

OIL EXPLORATION AND DEVELOPMENT IN THE NORTH DAKOTA WILLISTON BASIN: 1984-1985 UPDATE

by

David W. Fischer
and
John P. Bluemic


























MISCELLANEOUS SERIES NO. 67


NORTH DAKOTA GEOLOGICAL SURVEY

Sidney B. Anderson, Acting State Geologist

1986

SYSTEMS	GROUPS	ROCK UNITS
QUATERNARY		GLACIAL
	WHITE RIVER	GOLDEN VALLEY
TERTIARY	FORT UNION GROUP	SENTINEL BUTTE
		BULLION CREEK
		SLOPE
		CANNONBALL
		LUDLOW
		HELL CREEK
CRETACEOUS	MONTANA GROUP	FOX HILLS
		PIERRE
		JUDITH RIVER
		EAGLE 
	COLORADO GROUP	NIOBRARA
		CARLILE
		GREENHORN
		BELLE FOURCHE
		MOWRY
	DAKOTA GROUP	NEWCASTLE ^{ss}
SKULL CREEK		
INYAN KARA		
JURASSIC		SWIFT
		RIERDON
		PIPER
TRIASSIC		SPEARFISH 
PERMIAN		MINNEKAHTA
		OPECHE
PENNSYLVANIAN	MINNELUSA GROUP	BROOM CREEK
		AMSDEN
		TYLER 

MISSISSIPPIAN	BIG SNOWY GROUP	OTTER	
	MADISON GROUP	KIBBEY 	
		FORMAL INTERVALS	POPLAR INTERVAL
			RATCLIFFE INTERVAL 
			FROBISHER INTERVAL 
			ALIDA INTERVAL 
TILSTON INTERVAL 			
BOTTINEAU INTERVAL 			
DEVONIAN		BAKKEN 	
		THREE FORKS 	
		BIRDBEAR 	
		DUPEROW 	
		SOURIS RIVER 	
		DAWSON BAY 	
		PRAIRIE	
SILURIAN		WINNIPEGOSIS 	
		INTERLAKE 	
ORDOVICIAN	BIG HORN GROUP	STONEWALL 	
		STONY MTN. 	
CAMBRIAN		RED RIVER 	
		WINNIPEG GROUP 	
PRECAMBRIAN		DEADWOOD 	
			

● OIL PRODUCTION
 GAS PRODUCTION

ISSN:0078-1576

OIL EXPLORATION AND DEVELOPMENT IN THE NORTH DAKOTA

WILLISTON BASIN: 1984-1985 UPDATE

by

David W. Fischer
and
John P. Bluemle

MISCELLANEOUS SERIES NO. 67

NORTH DAKOTA GEOLOGICAL SURVEY

Sidney B. Anderson, Acting
State Geologist

1986

The cover shows a view of the
Mandan Refinery, just west of the
Missouri River. Photo courtesy
of D. D. Schatz, Amoco Oil Company.

CONTENTS

	Page
ILLUSTRATIONS	iv
INTRODUCTION	1
PRE-1951 EVENTS	1
POST-1951 EVENTS	2
THE 1970s RESURGENCE	6
THE 1980s	9
1980-1983	9
1984	16
1985	22
ADDITIONAL COMMENTS	23
REFERENCES	40

ILLUSTRATIONS

Figure		Page
1.	Map showing the extent of the Williston Basin	3
2.	Map showing the major structural features in western North and South Dakota, eastern Montana, and northeastern Wyoming	4
3.	Discoveries in North Dakota during the 1950s	5
4.	Major new field discoveries in North Dakota between 1960 and 1969	7
5.	Major new field discoveries in North Dakota between 1970 and 1977	8
6.	Major new field discoveries in North Dakota in 1978 and 1979	10
7.	Major new field discoveries in North Dakota in 1980 and 1981	11
8.	Average number of drilling rigs operating in North Dakota each year since 1950	13
9.	Major new field discoveries in North Dakota in 1982 and 1983	14
10.	Major new field discoveries in North Dakota in 1984 and 1985	15
11.	Graph showing the number of wells drilled in North Dakota each year since oil was discovered in 1951	17
12.	Graph showing the number of wildcat wells drilled in North Dakota each year since oil was discovered in 1951	18
13.	Graph showing the number of new oil pools discovered each year in North Dakota	19
14.	Annual crude oil production in North Dakota	21
15.	Geologic distribution of oil production in North Dakota	24

ILLUSTRATIONS--(Continued)

Figure	Page
16.	Graph showing the amount of oil and gas tax revenues collected by the State of North Dakota each year since 1970 26
17.	Income to the State of North Dakota from the sale (public auction) of oil and gas leases for state-owned lands 27
18.	Average price per acre paid in oil and gas lease sales 28
19.	Map of western North Dakota showing approximate extent of all known oil pools as of August 1, 1986 39
Table	Page
1.	North Dakota Oil and Gas Discoveries in 1984 and 1985 Listed by County and Geologic Horizon 20
2.	Percentage of Tax Income to State of North Dakota from Various Sources (figures given as percent of total revenues) 29
3.	Oil and Gas Discovery Wells in North Dakota During 1984 30
4.	Oil and Gas Discovery Wells in North Dakota During 1985 35

INTRODUCTION

North Dakota is now experiencing a downturn in oil production, the result of the severe cutbacks in exploration over the past two years. After peaking at 52.6 million barrels of oil in 1984, North Dakota's production dropped off to 50.9 million barrels in 1985 and it can be expected to continue dropping as older producing wells decline and fewer new wells are drilled to replace them. In this, as in the previous four versions of this report, we will briefly outline the several exploration cycles the Williston Basin has undergone, review development of the significant reservoirs, and list significant statistics about North Dakota's oil exploration and production trends. The data presented here are largely from the files of the North Dakota Geological Survey. Much of the data for the years since 1980 were provided by the Oil and Gas Division of the North Dakota Industrial Commission, but all of the interpretations are our own.

PRE-1951 EVENTS

Natural gas, known to most people around the turn of the century as "marsh gas," was first reported in southeastern North Dakota in 1892 in an artesian well producing from the "Dakota" sandstone. Subsequently, the gas was obtained from many artesian wells in a belt extending south from Jamestown to Merricourt. This methane gas was used for lights, cooking, and heating at Edgeley. It apparently occurred in an unsaturated solution with the artesian water and, as the water pressure was released when it flowed to the surface, the gas was collected in tanks. Although enough gas was found to supply the small towns in the area, improper drilling

and maintenance of the wells resulted in blowouts, plugging, and loss of head. When the artesian head was lowered below the land surface, gas production stopped, and by 1920 the gas was used only on a few scattered farms. No record was made of pressure or production of the gas, which occurred at a depth of about 1,100 to 1,200 feet.

Natural gas was also utilized in the Westhope and Lansford areas of Bottineau County prior to 1910. This gas, which was used to heat and light 13 homes in Lansford by use of an underground pipeline system, occurs in the glacial deposits. Many local farmers in that area had installed separators and used the gas to heat barns and other structures, apparently for several years before 1910. At Lansford, the gas was found at depths of 175 to 210 feet from a 19-foot-thick glacial sand. At about that time too, a company known as the North Dakota Gas Company supplied gas to the town of Westhope. The gas was delivered to the town through a 20-mile pipeline. The eight wells cost 13.6 cents per foot to drill and charges to the townspeople were 30 cents per 1,000 cubic feet of gas in summer, 40 cents in winter.

In April, 1916, State Geologist A. G. Leonard visited the Williston area to determine the likelihood of finding oil or gas in that vicinity. His report on his findings advised against going to the expense of drilling a well there. The following month, Leonard visited Marmarth for a similar purpose at the request of Governor Hanna and recommended drilling in that area.

In September, 1916, a wildcat well was started by the Des Lacs Western Oil Company on the farm of A. F. Blum, about 1½ miles southeast of Lone Tree in Ward County. The well was abandoned at 244½ feet in October, 1916.

In September of 1917, the Des Lacs Western Oil Company asked the North Dakota Geological Survey to investigate the possibilities of finding oil and gas in the Minot area. Dr. Leonard and Assistant State Geologist, Howard Simpson, found enough evidence to recommend further exploration. On the basis of their report, a well was drilled about two miles west of Des Lacs in 1923. The well penetrated 3,980 feet deep, into the Cretaceous Inyan Kara Formation, but it was nonproductive. It was located only two miles east of present Madison production in the Lone Tree Field.

In 1933, Professor William E. Budge of the School of Mines had taken an interest in the occurrence of oil shale and oil seeps along the Sheyenne River south of the Fort Totten Indian Reservation. These had been called to his attention by interested citizens of Warwick. He made several trips to the area and attempted to get an appropriation from the 1935 Legislature to make further studies of the area, but he was unsuccessful in obtaining funding. Professor Budge believed that the best way to evaluate the area would be by seismic methods as the area is covered by glacial sediment.

On August 15, 1938, the California Company abandoned its Nels Kamp #1 well in Williams County. This well was drilled less than one mile from what is now Capa Field and approximately one quarter of a mile from a well completed in 1956 in the Silurian. The Kamp well was junked at 10,281 feet in the Devonian. This well was the first in North Dakota on which an electric log was run. While State Geologist Wilson M. Laird was out of town, Acting State Geologist Nicholas Kohanowski signed the drilling permit for Amerada Petroleum Corporation's #1 Clarence Iverson well to be drilled in the SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec

6, T155N, R95W, Williams County. The permit was issued on August 4, 1950. Drilling began at 6:00 a.m. on September 3. On January 4, 1951, a drill-stem test (from 10,452 to 10,803 feet) recovered one pint of free oil in the bottom of the test tool. The recovery was from the Devonian Duperow Formation. However, the well was completed in the Silurian Interlake Formation on April 4, 1951.

POST-1951 EVENTS

North Dakota's 1951 Nesson Anticline discovery was not the first oil production from the Williston Basin (fig. 1). Oil was discovered in the Williston Basin in Montana on the Cedar Creek Anticline (fig. 2) in 1936 and in Manitoba in 1950. Since 1951, several significant cycles of exploration and production have been completed in North Dakota. Annual production increased in North Dakota until 1966 (26 million barrels) then declined until 1974 (19.6 million barrels). Production in 1979 (31 million barrels) surpassed the previous 1966 high and new highs were recorded each year until 1984 when production again began to decline.

Although the initial oil discovery in North Dakota was from Silurian rocks, the early development of the Nesson Anticline (fig. 2) was primarily of the Madison reservoirs. The peak discovery period was 1952-1953, with development along the 75-mile anticline trend being nearly complete by 1960 (fig. 3). Producing capacity at that time exceeded the available market (the Mandan refinery). Production was limited then by prorationing until November of 1965, when natural decline of these reservoirs equaled the market demand. The only significant deeper horizons developed along the

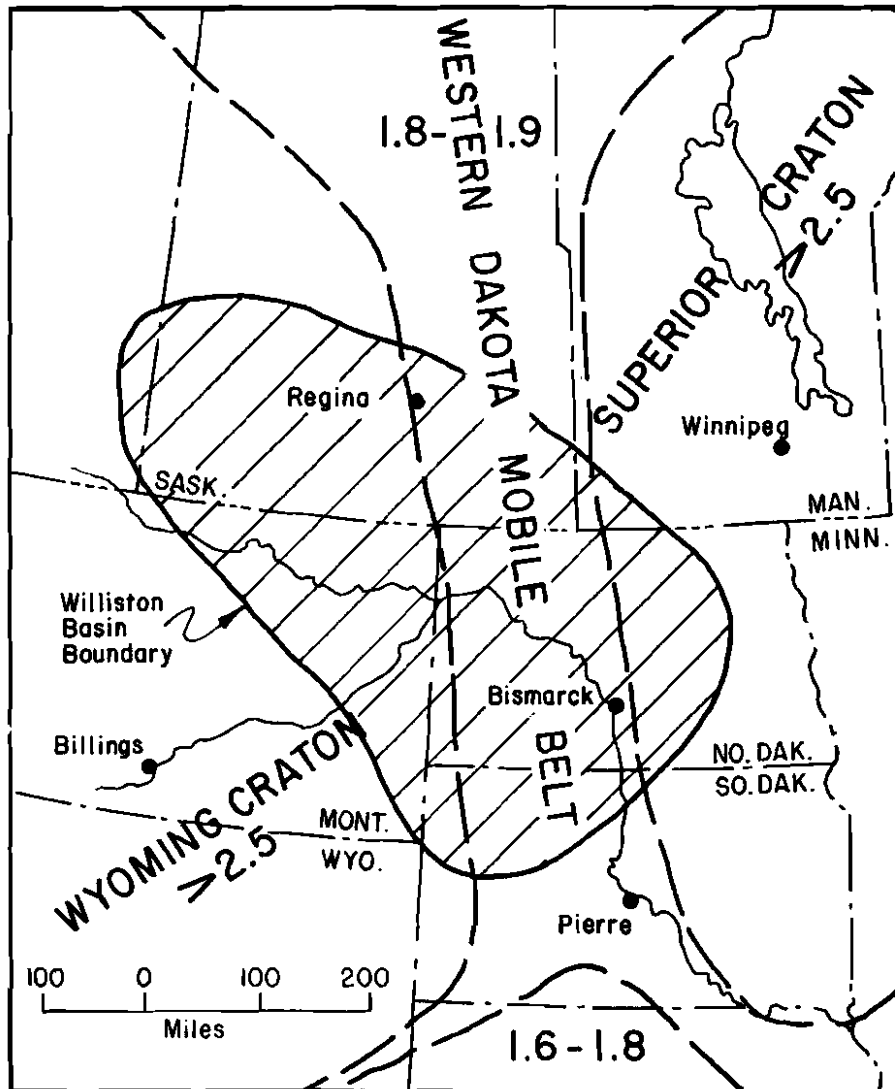


Figure 1. Map showing the extent of the Williston Basin. The major Precambrian structural provinces (Superior Craton, Western Dakota Mobile Belt, and Wyoming Craton) are shown along with the approximate ages of the basement rocks in each area; e.g. rocks of the Wyoming Craton are greater than 2.5 billion years old; rocks of the Western Dakota Mobile Belt range in age from 1.8 to 1.9 billion years old.

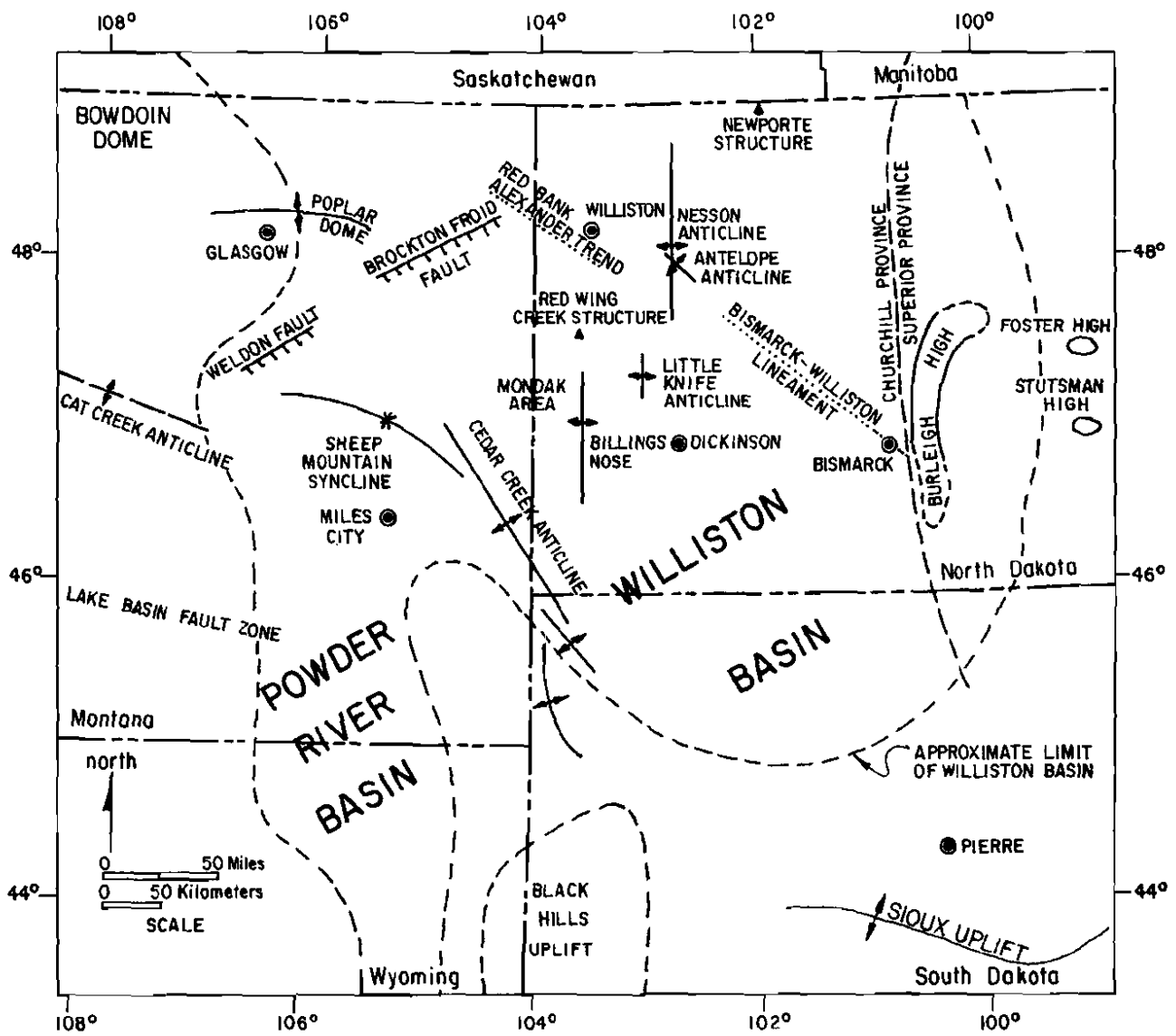


Figure 2. Map showing the major structural features in western North and South Dakota, eastern Montana, and northeastern Wyoming.

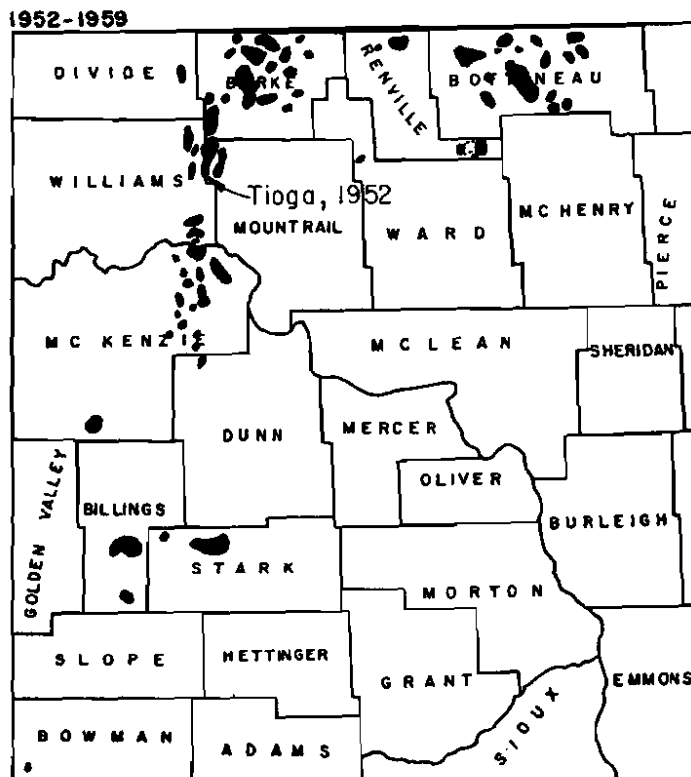
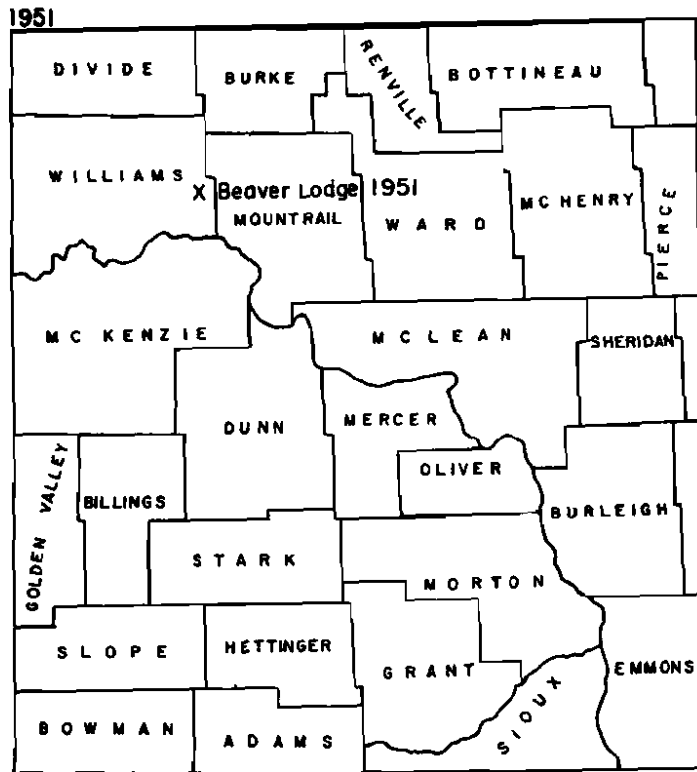


Figure 3. Discoveries in North Dakota during the 1950s. The upper map of western North Dakota shows the location of the Beaver Lodge discovery in 1951. The lower map shows oil fields developed by the end of the 1950s. The Tioga discovery of 1952 is also noted.

Nesson trend during the early 1960s were the Duperow and Interlake Pools in the Beaver Lodge and Antelope Fields. The shallower Sanish Pool in Antelope Field was also undergoing development at this time.

Significant discoveries between 1952 and 1959 included the Mississippian oil fields of Bottineau, Burke, and Renville Counties (fig. 3). The increasing production between 1958 and 1961 largely reflects development of these pools.

Tyler sand reservoirs, which were discovered at Rocky Ridge in 1957 and Fryburg in 1959, became important developments in the mid-60s in the Stark and Billings County areas. Peak production occurred in 1966 at Medora Field and in 1967 in the Dickinson Field. This helped to offset declines in the older producing areas.

In 1960, discovery of the Cedar Creek Pool extended the Red River production along the Cedar Creek Anticline into North Dakota (figs. 2 and 4). The Bowman County Red River play extended production in southwestern North Dakota to small "bumps" along the eastern flank of the structure in the period from 1967 to the mid-70s.

The decline in production from 1966 to 1974 represents the failure of new discoveries to replace the natural decline of the major producing areas. The normal pattern is discovery, followed by development, leading to peak production for one to three years, followed by a gradual decline. Secondary recovery methods are used in an attempt to alter this pattern. Water injection for pressure maintenance was installed in many of the Madison reservoirs along the Nesson trend, and in Burke County, but this technique was relatively unsuccessful. Similar programs, begun in 1967 in the Newburg-Spearfish and Madison reservoirs, in 1970 in the

Medora Field, and in 1973 in the Tyler sand reservoirs in the Dickinson Field, increased production levels above the initial development in those fields. However, these successful programs could not offset the natural decline of the major producing areas.

The trend to lower exploratory activity during the 1960s generally followed the national trend. The upsurge of wildcatting in 1968 in North Dakota has been referred to as the "Muddy sand" (Newcastle) play. It followed development of the Bell Creek Field in Montana, but no similar occurrences were found in North Dakota and exploration activity again slowed down.

THE 1970s RESURGENCE

Two events that occurred close together in the early 1970s significantly changed Williston Basin production history. First, Red Wing Creek Field was discovered in 1972 in McKenzie County, North Dakota (figs. 2 and 5). Second, OPEC, which was formed in 1973, enacted production controls (embargoes) and price increases on production in OPEC countries.

OPEC created the first substantial worldwide increase in the price of oil. The price rose from about \$4.00 a barrel in 1973 to about \$9.00 in 1974 and prices continued to rise through the 1970s. As a result, exploration was once again a profitable venture. Prior to this, many companies found that exploration risk money had a better return in a regular bank savings account than in actual wildcat drilling. The increased price created risk capital, and thus exploratory drilling was enhanced.

The Red Wing Creek discovery at about the same time excited basin oil operators because of the

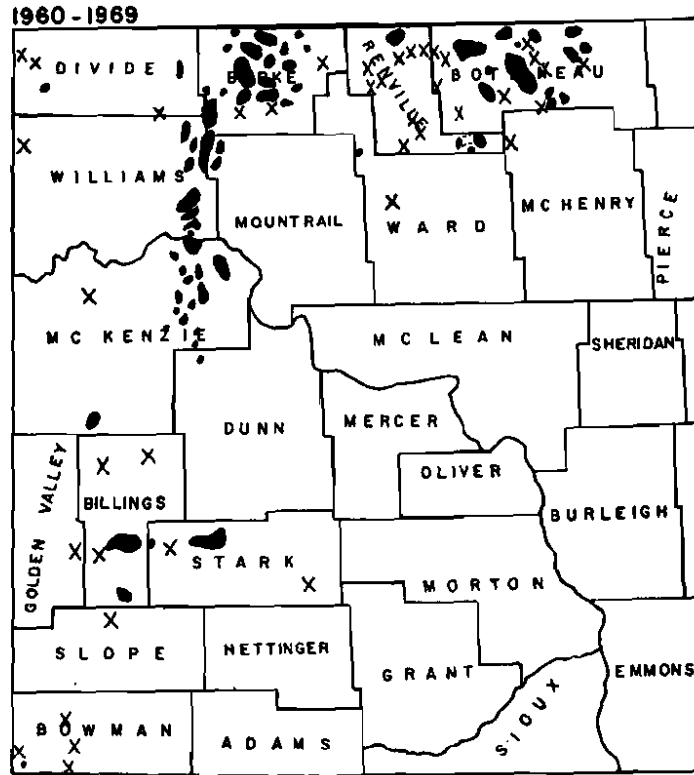


Figure 4. Major new field discoveries in North Dakota between 1960 and 1969.

relatively high productivity of the wells and the anomalously thick pay section. Since no one really understood the nature of the Red Wing Creek structure (fig. 2) at the time, industry's response was to gain lease foothold in the area. The lease play set off by the Red Wing Creek discovery set the stage for further development. The five-year-term leases taken in western North Dakota tended to increase exploratory activity. The availability of venture capital, coupled with the five-year-

leases, caused exploratory drilling to increase in 1975 and 1976, in part in response to the lease expiration dates.

In 1977, two additional significant discoveries were drilled. The first of these, the Charlson-Silurian Pool (fig. 5), proved that production rates in excess of 2,000 barrels of oil a day were possible in North Dakota. Although the multiple-pay Mondak Field, discovered in 1976, turned out to be one of North Dakota's largest oil fields, it was

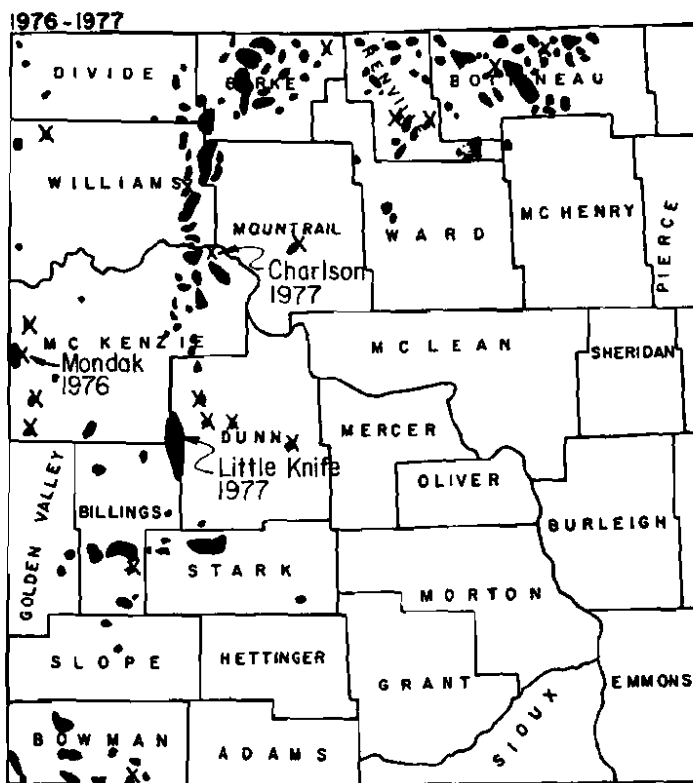
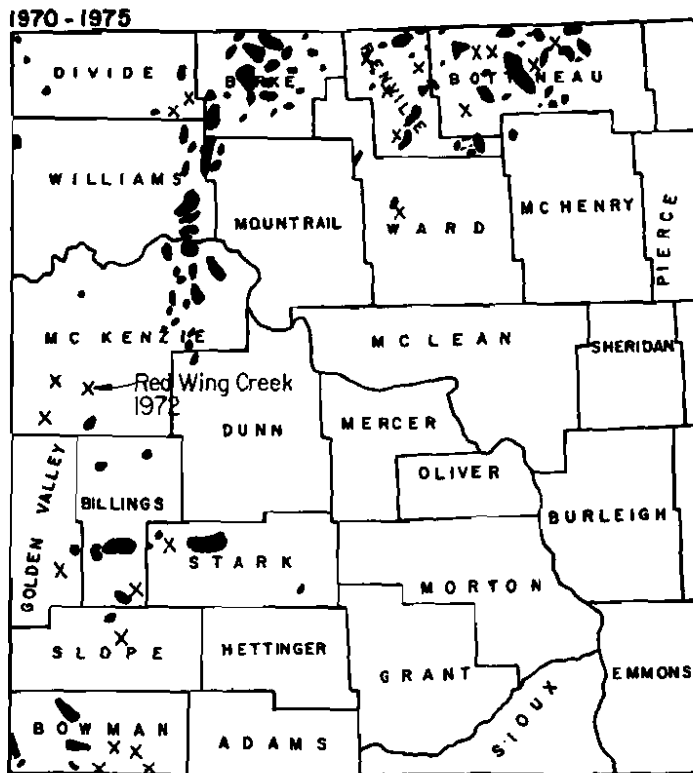


Figure 5. Major new field discoveries (x symbols) between 1970 and 1975 (upper map) and in 1976-1977 (lower map).

the discovery of Little Knife in 1977 (fig. 5) that drew national attention to North Dakota. Located at the junction of Billings, Dunn, and McKenzie Counties, Little Knife Field demonstrated potential for several zones of production. It is easily over a 100-million-barrel-reserve field.

Drilling continued to increase in 1978 and the wildcat success ratio also improved. Several important 1978 discoveries changed exploration ideas about North Dakota's Williston Basin. Perhaps the most interesting of these was the discovery of Shell Oil Company's Newporte Field in northern Renville County (fig. 6). This opened the first significant Cambrian production in the state, although some Cambrian gas and Cambro-Ordovician hydrocarbons had been produced on the Nesson Anticline. The discoveries at Missouri Ridge and Springbrook north of Williston opened production in southern Williams County and northern McKenzie County. The discovery of Bull Moose Field in McKenzie County and T. R. Field in Billings County were significant in establishing these counties as a region of major production, and delineating a major north-south structural trend, the Billings Anticline (fig. 2).

Continued successes on the Billings Anticline and the Mondak Field were highlights in 1979 and 1980 (figs. 6 and 7). The success on the Billings Anticline vaulted Billings County into the number one producing spot in North Dakota, where it remained until May, 1984 when it was overtaken once again by McKenzie County. Big Stick, Four Eyes, and Whiskey Joe Fields were discovered on the Billings Anticline in 1979. These fields are multiple pay, producing from the Ordovician Red River, Devonian Duperow, Mississippian Bakken, and Mississippian Madison, with the Madison being the

major producing interval. Big Stick Field has many wells with initial productions exceeding 400 to 500 barrels of oil per day and several with initial productions above 2,000 barrels of oil per day.

Mondak Field is another multiple-pay field with the Madison being the primary producing horizon. The wells there are not as prolific as those on the Billings Anticline, but the field currently covers about 125 square miles in North Dakota alone with 171 wells in the Madison, 4 in the Red River, and 1 each in the Bakken, Duperow, and Tyler.

THE 1980s

1980-1983

Deep pool successes on the Nesson Anticline were the highlights of this older producing feature during the early 80s. Notable among them were Texaco's Silurian and Ordovician Red River discoveries in Blue Butte Field (an old Madison field), and Northwest Exploration's Dawson Bay and Red River successes along its western flanks, near the north end of the anticline. The Dawson Bay production was also important because it added a new formation to the list of producing formations in the state (the Dawson Bay production has, however, since been plugged).

Two new counties were added to the list of North Dakota producers in 1980 with Amoco's Red River discovery in Hettinger County (Tepee Butte Field) and Conoco's Red River success in Mercer County (Dodge Field) (fig. 7). Tepee Butte Field continues to produce from one well, but the single Mercer County well was plugged in 1982.

Discoveries were also made in Golden Valley and Slope Counties in 1980, far from already existing production. Amerada Hess completed

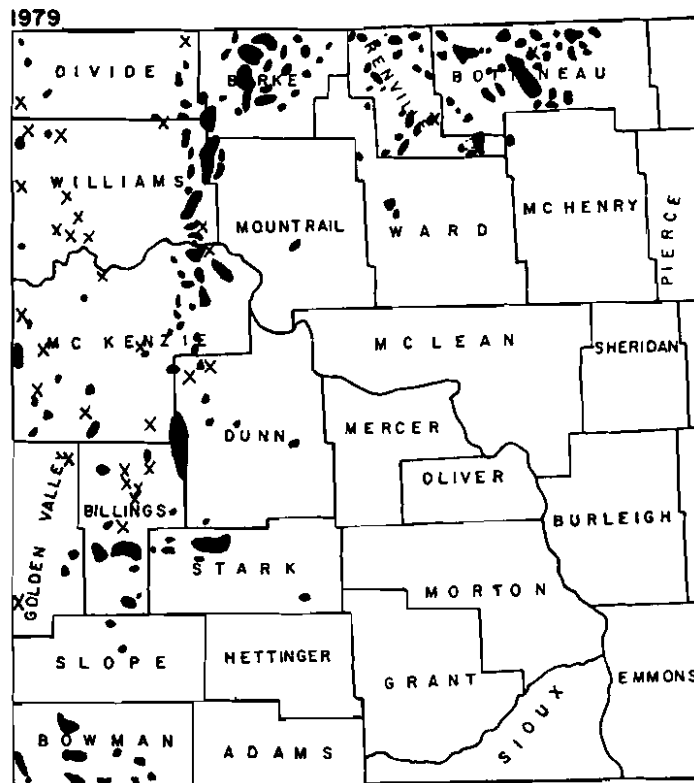
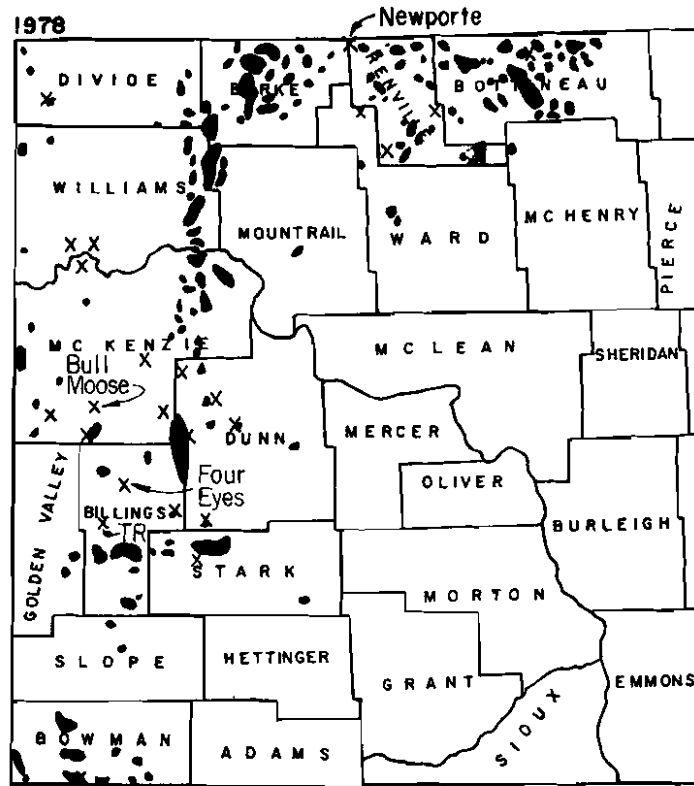


Figure 6. New field discoveries in North Dakota in 1978 (upper map) and in 1979 (lower map).

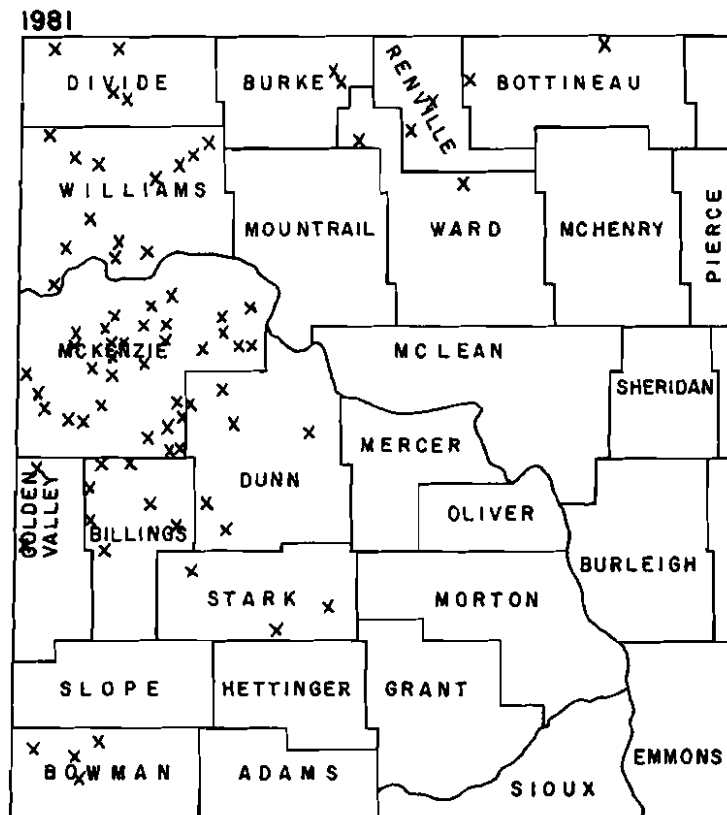
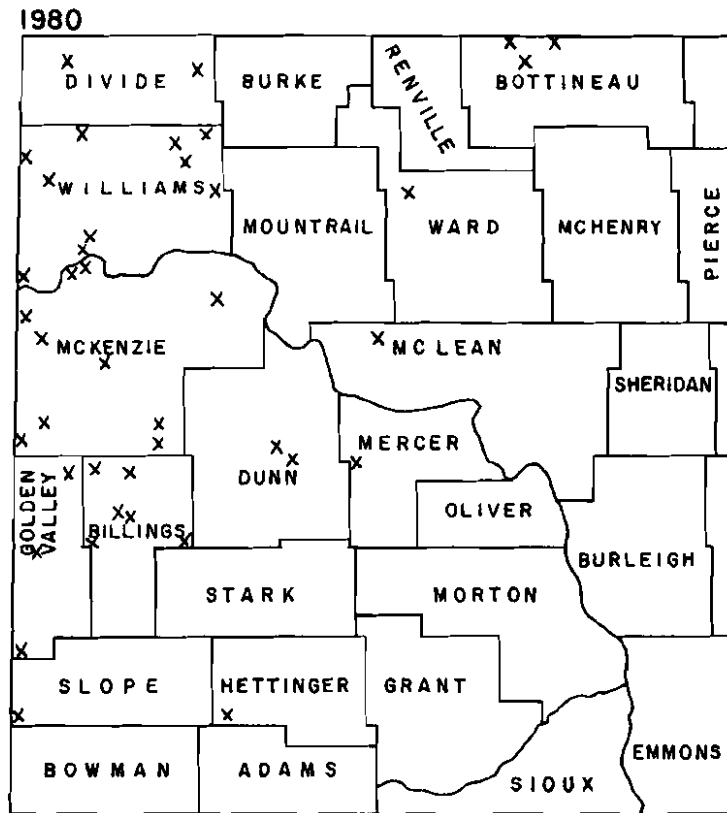


Figure 7. New field discoveries in North Dakota in 1980 (upper map) and in 1981 (lower map). Existing oil fields at the time are not included on the remaining discovery maps to minimize clutter.

the southernmost Madison producer in North Dakota in Golden Valley County (Bull Run Field) and Terra Resources completed a Red River well in what is now the Marmarth Field in western Slope County.

In northern Williams County, Hunt completed a Lodgepole producer in the Corinth Field near the town of Wildrose. This was not a big well, but it was important because it produced from a horizon that was largely overlooked in the past. The two wells that were completed in Corinth Field have since been abandoned.

Several of the new pool discoveries recorded in 1981 are of more than passing interest. Gulf's Richardton Field discovery in Stark County came in with an initial gas production of 3,588 MCF and 150 barrels of condensate per day from the Winnipeg-Deadwood. Gulf's two Lone Butte discoveries in the Madison and Red River extended the trend of the Little Knife Field northward. Lone Butte went on to become an important field; a total of 21 wells currently produce there. In Dunn County, Amoco's Skachenko "A" #1 came in at 1,652 barrels of oil per day from the Duperow, placing the Jim Creek Field between the Killdeer and Rattlesnake Point Fields, both of which also produce from the Devonian. This well is still producing about 275 barrels of oil a day.

The discovery of oil in 1981 in the Bluell beds of the upper Mission Canyon Formation in north-central Burke County (fig. 7) heightened interest in this horizon as well as in the slightly deeper Sherwood bed. Earlier production was from the higher Midale and Rival subintervals.

Lower prices resulting from an oversupply of crude oil and high drilling costs, coupled with other economic factors resulted in a

downturn in exploratory drilling activity in 1982 in the Williston Basin (fig. 8). Activity in 1982 was characterized by development drilling and tests for deeper producing horizons in existing fields.

In McKenzie County, discoveries of new producing horizons in established fields added considerable production. A few examples are the Elk-Silurian Pool, Keene-Silurian Pool, and the Indian Hills-Madison and Silurian Pools. Discoveries in McKenzie County in 1982 included Buffalo Wallow, Camp, and Ragged Butte Fields (fig. 9).

In Williams County, activity centered in the Williston area. Highlighting the 1982 activity were several new field discoveries, including Last Chance, Eightmile, and Hardscrabble Fields. Elsewhere in Williams County, the discovery of a Winnipegosis pool in Temple Field is significant. Three new Red River fields were discovered in Divide County in 1982 (fig. 9). Elsewhere, the Bell Field discovery in northwestern Stark County continued the Tyler trend through the area and the Dobson Butte-Silurian Pool added to the several isolated deep-pool discoveries in Stark County.

Exploration in North Dakota continued to slow in 1983 as a result of lower and unstable oil prices. The total number of wells drilled in 1983 decreased to 480 wells and a shift in drilling strategy was noted as the number of Red River Formation tests decreased markedly.

McKenzie County activity in 1983 and since has been concentrated mainly in the area south of Williston (fig. 10) (Glassbluff, Indian Hills, Elk, Camp, and Sioux Fields) where a number of prolific wells have been completed. Continued deep development on the Nesson Anticline resulted in a number of Silurian completions in Keene, Blue Buttes, and Camel Butte Fields in 1983. In northern and

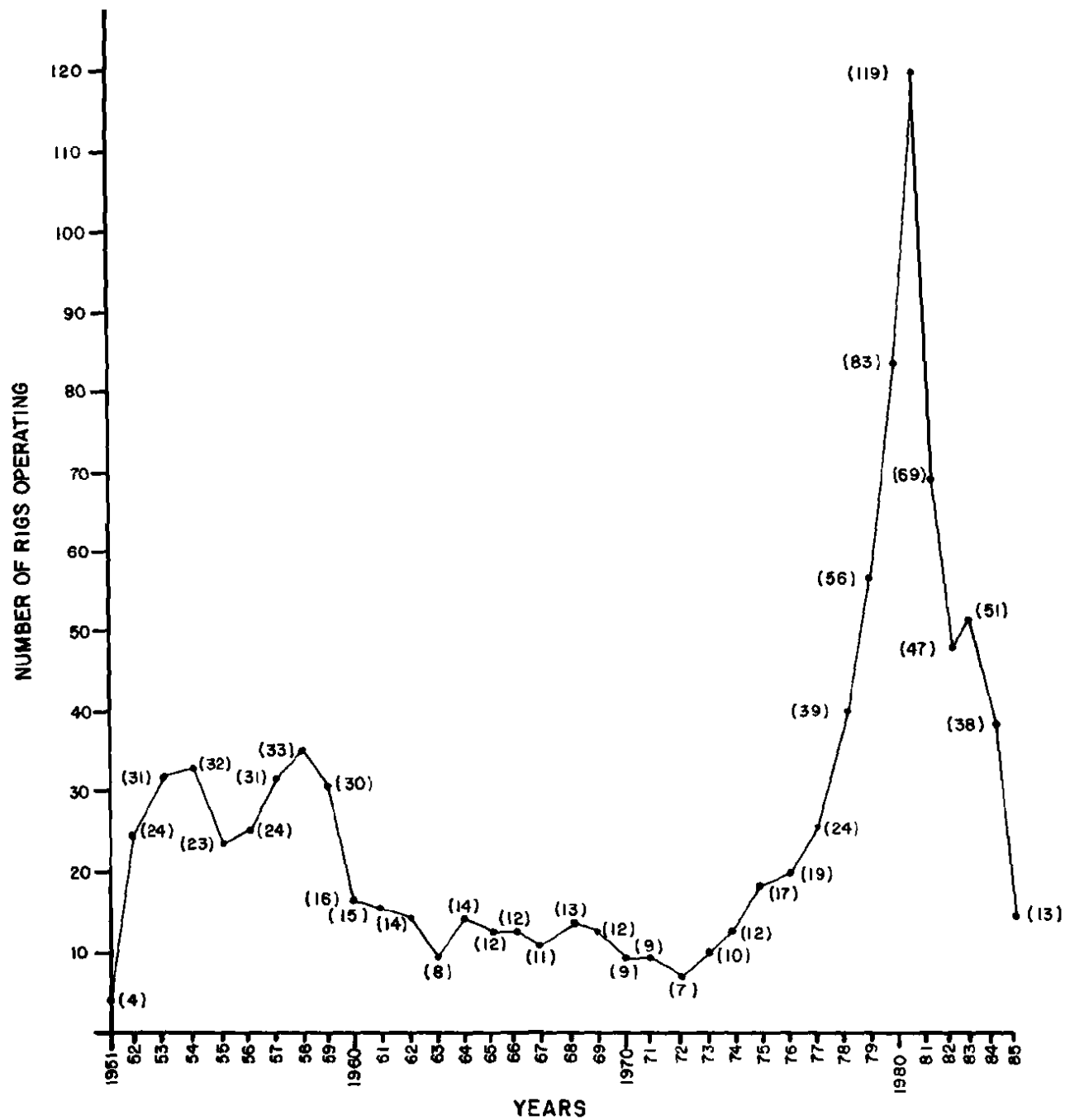


Figure 8. Average number of drilling rigs operating in North Dakota each year since 1950 (sum of the weekly averages divided by 52).

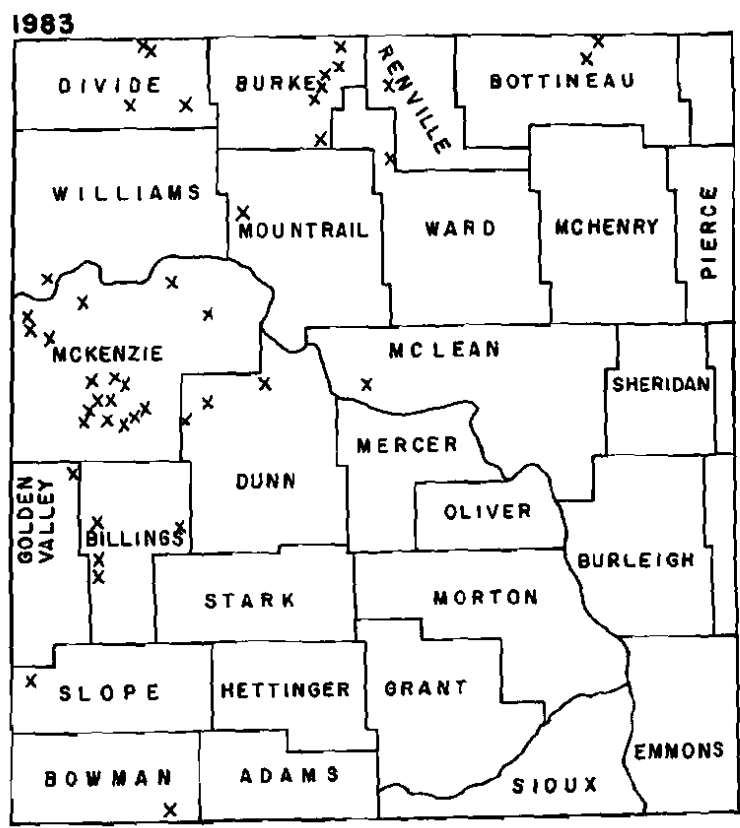
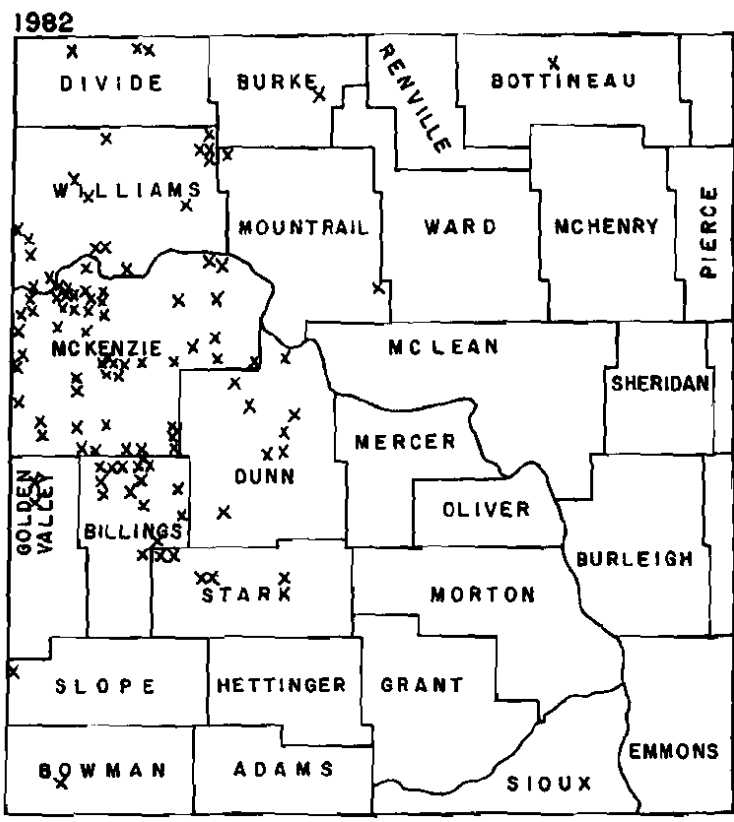
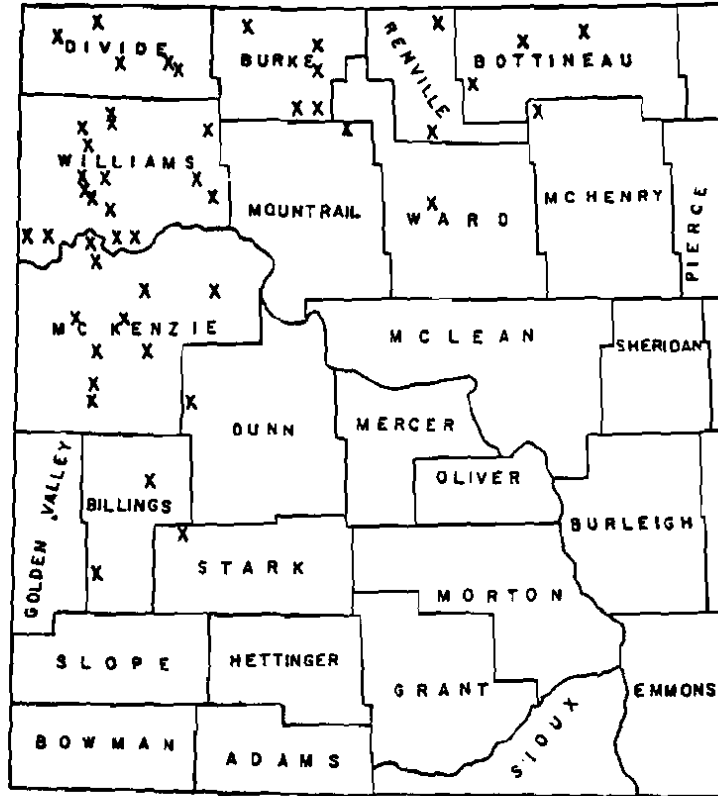


Figure 9. New field discoveries in 1982 (upper map) and 1983 (lower map).

1984



1985

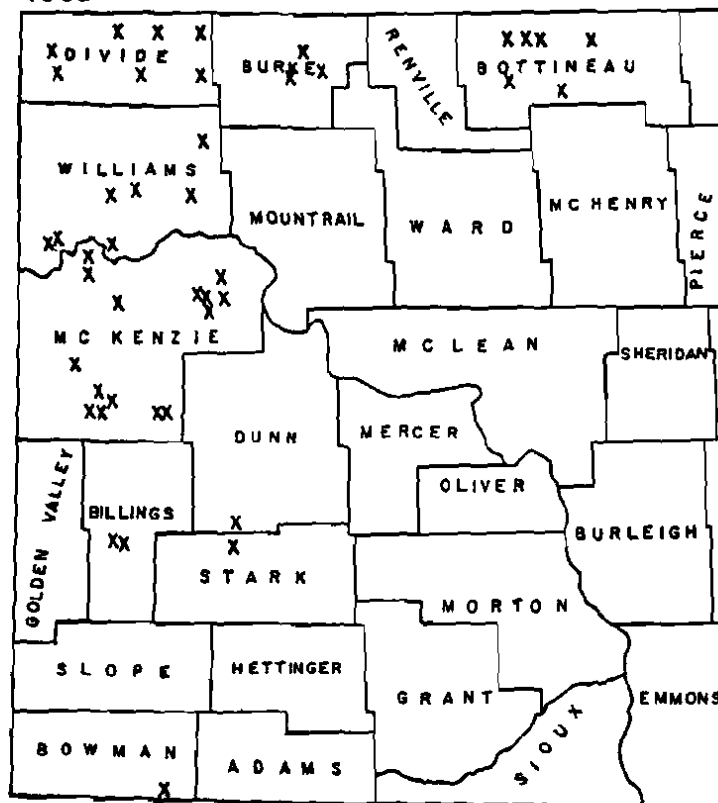


Figure 10. New field discoveries in 1984 (upper map) and 1985 (lower map).

western parts of McKenzie County, wildcat drilling in 1983 resulted in a number of discoveries, ranging from the Red River to the Madison. New field discoveries included the Snowcover-Red River and the Buffalo Wallow-Madison and Duperow Pools.

Increased exploratory activity in Divide County, headed by Conoco, Louisiana Land and Exploration, and Texaco, resulted in several discoveries in the Red River and Duperow Formations. A new Winnipegosis discovery, Moraine Field, continues to point to the possibility of that formation becoming an increasingly sought-after basin target.

Drilling was highlighted in Billings County in 1983 by the discovery of Knutson and Bullsnake Fields, both Madison pays.

Significant Duperow production was established in Bear Creek Field in Dunn County. By year's end, over 900 barrels of oil were being produced daily from the three Devonian wells in Bear Creek Field.

Continued exploration in the northeastern portion of the North Dakota Williston Basin resulted in a number of new field discoveries in 1983. Notable among these fields was the McKinney Madison Field in western Renville County.

1984

A total of 664 wells¹ were drilled for oil and gas in North Dakota during 1984, an increase of 184 wells from the 480 wells drilled in 1983 (fig. 11). Of these, 357

wells were listed as capable of production, a 54 percent success rate. Of the total 168 wildcats² drilled (fig. 12) 27 were indicated producers, a 16 percent success rate (fig. 13). That compares to a 26 percent success rate in 1983 and 30 percent in 1982. A total of 5,930,634 feet were drilled in 1984. Table 1 lists the discoveries, by formation, for each county in North Dakota during 1984 and 1985. Oil production in North Dakota in 1984 reached 52.6 million barrels, the most ever (fig. 14).

Development drilling and deeper pool discoveries highlighted activity in McKenzie County during 1984. Over 80 wells were successfully completed in the Indian Hills-Elk Fields area. The Devonian Duperow was put on line in Indian Hills Field with the successful completion of the Superior (Mobil) Oil Company's Nelson #2-2. Currently, five wells are producing from the Indian Hills-Duperow at a rate of over 600 barrels a day. Milestone (Meridian) Oil and Gas found good Bakken production in Pierre Creek Field in McKenzie County. The Milestone (Meridian) Federal #22-28 was completed in the Bakken for 175 BOPD. Stony Mountain production was put on line at Johnson Corner Field with the Texaco et al. State of North Dakota #'D' 1 for 362 BOPD. Prior to that discovery, Stony Mountain Field was already productive in the Bakken and Red River Formations.

Activity in Williams County in 1984 was concentrated near Williston,

¹ Figures were compiled by the Oil and Gas Division of the North Dakota State Industrial Commission.

² The Oil and Gas Division of the North Dakota State Industrial Commission defines a wildcat as any well 1 mile from a field boundary, a development well as any well within a field boundary (regardless of the depth penetrated), and an extension as any well within 1 mile of a field boundary.

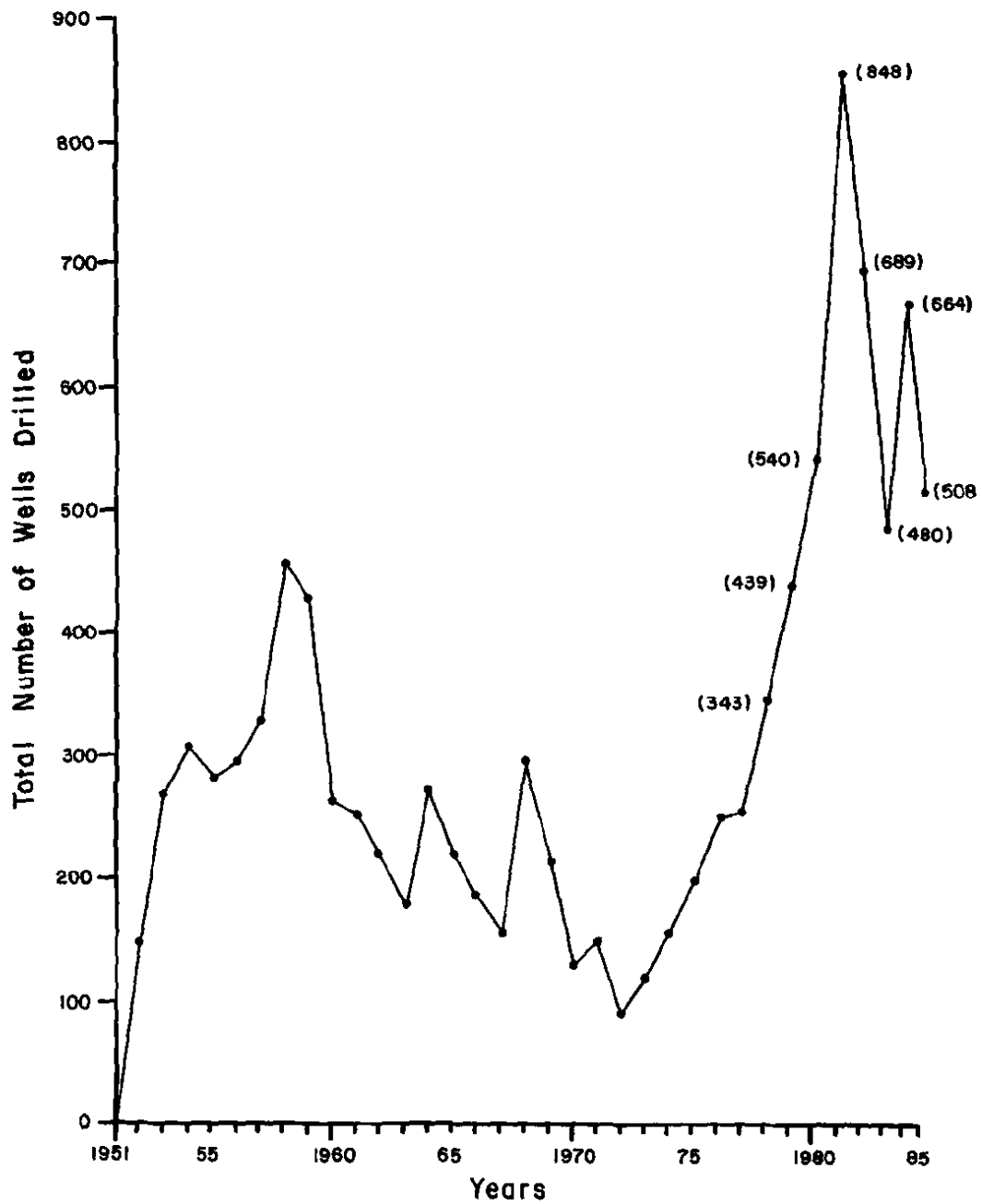


Figure 11. Graph showing the number of wells drilled in North Dakota each year since oil was discovered in 1951. The total for each year includes both exploratory and development wells.

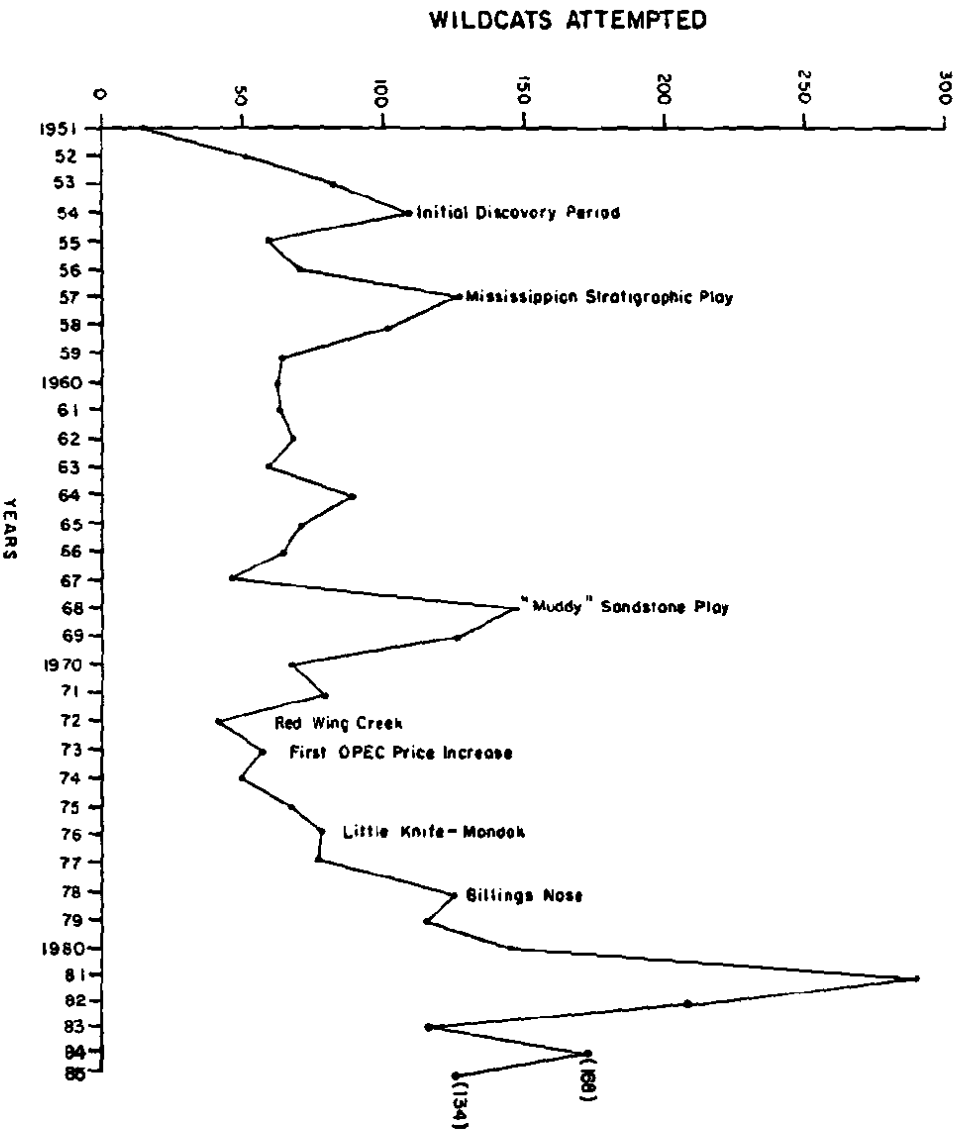


Figure 12. Graph showing the number of wildcat wells drilled in North Dakota each year since oil was discovered in 1951. Some of the major events affecting drilling activity are noted on the graph.

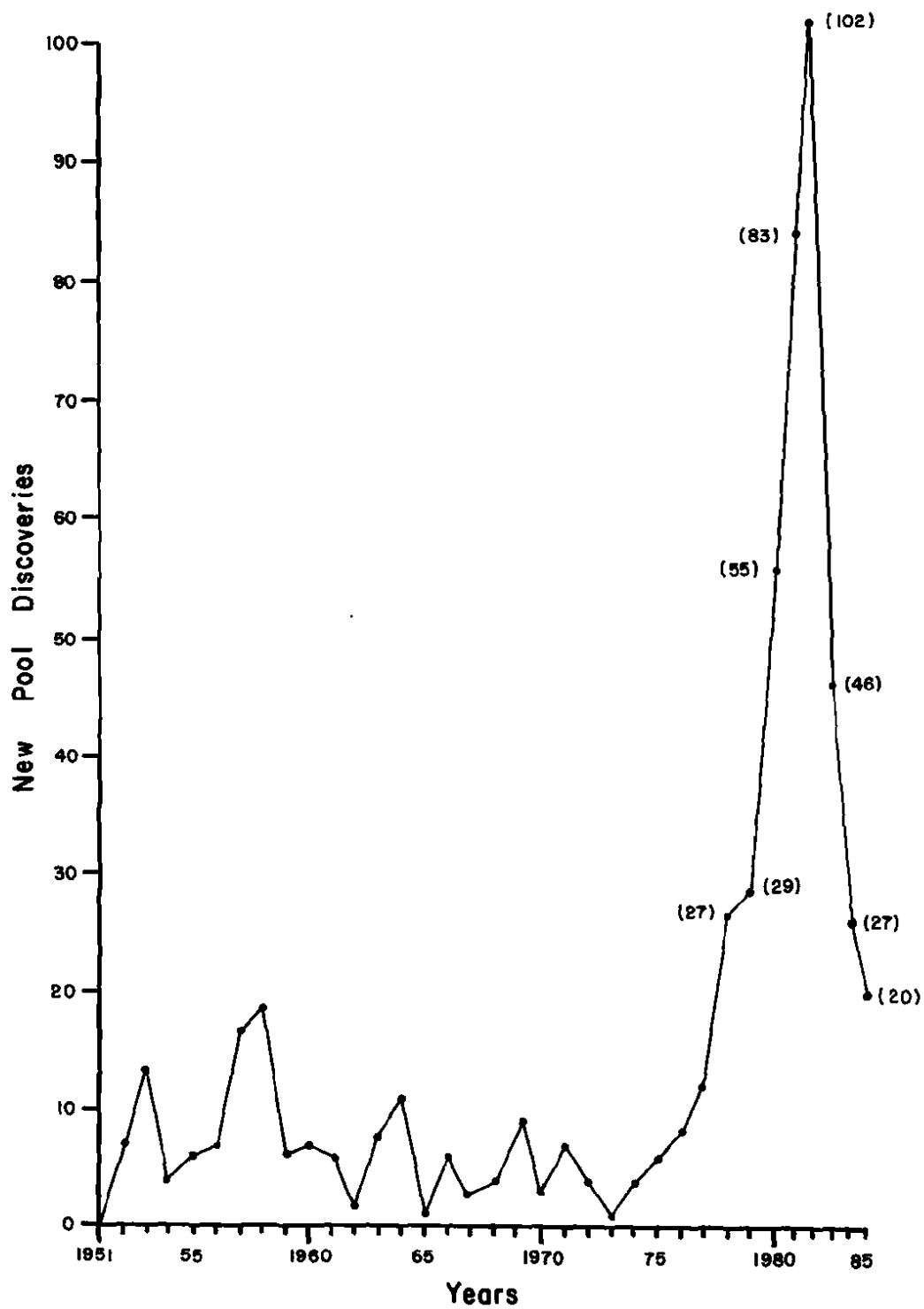


Figure 13. Graph showing the number of new oil pools discovered each year in North Dakota.

TABLE 1.--North Dakota Oil and Gas Discoveries in 1984 and 1985,
Listed by County and Geologic Horizon.

	<u>1984</u>	<u>1985</u>		<u>1984</u>	<u>1985</u>
Billings County Total	2	2	McKenzie County Total	10	16
Tyler	0	1	Madison	2	4
Madison	1	0	Bakken	1	1
Bakken	0	1	Birdbear	1	1
Duperow	1	0	Duperow	2	4
Bottineau County Total	3	6	Silurian	0	2
Spearfish	1	1	Stony Mountain	1	1
Madison	2	5	Red River	3	3
Bowman County Total	0	1	Mountrail County Total	1	0
Red River	0	1	Madison	1	0
Burke County Total	5	3	Renville County Total	2	0
Madison	5	3	Madison	2	0
Divide County Total	5	7	Stark County Total	1	1
Madison	0	1	Tyler	1	1
Duperow	2	4	Ward County Total	1	0
Winnipegosis	0	1	Madison	1	0
Gunton	1	1	Williams County Total	16	8
Red River	2	0	Madison	11	3
Dunn County Total	1	1	Birdbear	0	1
Madison	0	1	Duperow	1	2
Red River	1	0	Silurian	2	0
McHenry County Total	1	0	Stonewall	1	0
Madison	1	0	Red River	1	2

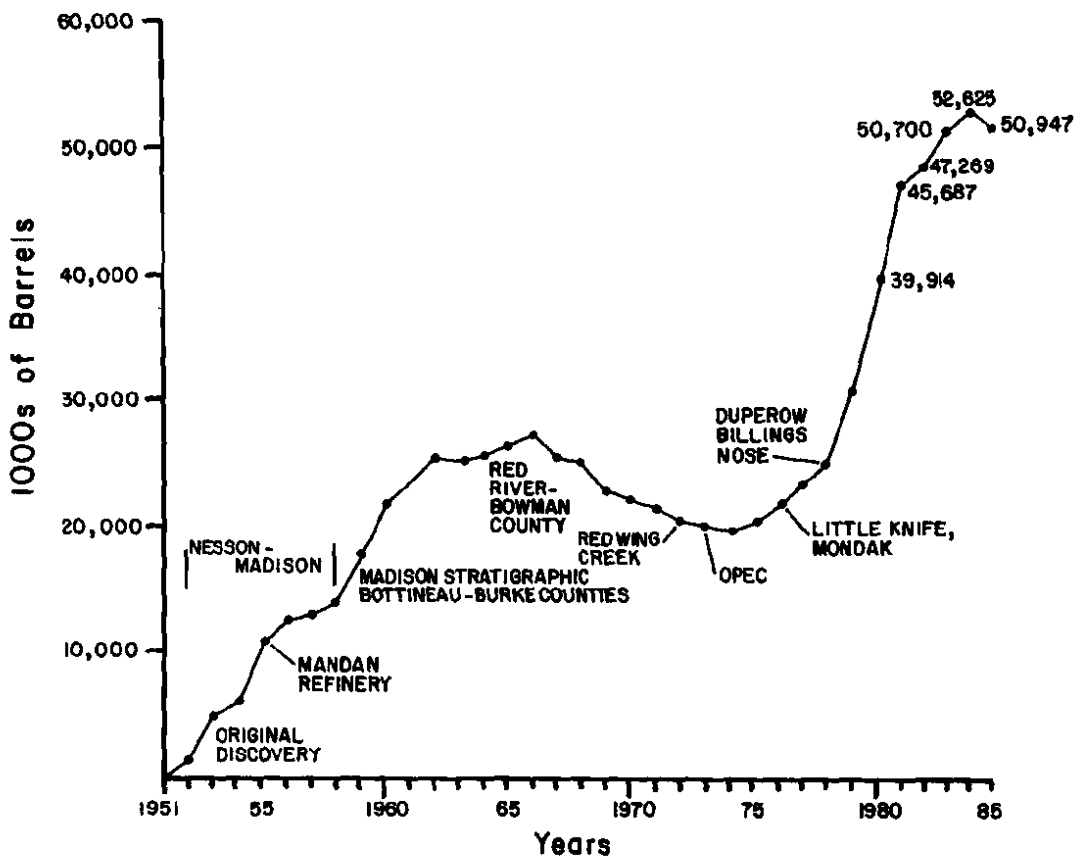


Figure 14. Annual crude oil production in North Dakota. Figures (since 1980) are given in thousands of barrels; thus, production in 1984 was 52,625,000 barrels of oil. Major events affecting oil production history are noted on the graph.

an extension of the McKenzie County activity. A Madison pool was discovered by Gulf Oil Corporation (Chevron) in Hardscrabble Field. The Skurdahl #2-24-1B was completed for 339 BOPD. The well was not immediately offset; five wells currently are producing from the Hardscrabble Madison pool, with additional reserves indicated behind pipe in wells producing from deeper horizons. Significant Madison production was also established by Atlantic Richfield Oil Corporation in what is now East Fork Field. The Irgens #1-27 was completed in an apparent fracture-enhanced Madison reservoir for 662 BOPD. There are currently twelve producing wells in East Fork Field, with more locations scheduled, by Depco, which purchased ARCO's interest in the field.

Three Devonian fields were discovered in Divide County in 1984. Gooseneck Field, discovered by Conoco's Halvorson #31-5 well is an eight-well field with production currently averaging 45 BOPD per well. Musta Field, discovered by Solar Petroleum's Johnson #1 well for 38 BOPD, is now a two-well field. Colgan Field, discovered by Louisiana Land and Exploration's State #1-43-6, was completed for 76 BOPD in the Duperow, and remains a one-well field. Although the Duperow production in Divide County is relatively low volume, it is interesting in as much as the trapping mechanism may be unique to the area. Other discoveries in Divide County in 1984 included the Gunton and Red River.

Exploration in the northeastern portion of the North Dakota Williston Basin resulted in 13 new field discoveries (fig. 10) in 1984. The Spearfish play that was so important in Manitoba did not develop as anticipated in North Dakota, though one Spearfish field, Red Rocks, was discovered in 1984. The Kennedy and Mitchell Incorpor-

ated's Magnuson Turtle Mountain #55-752-1 well was completed for 18 BOPD from perforations in the "water sands." Elsewhere, Century Oil and Gas's Opseth #29-7, the discovery well for South Coteau Field, was completed in the Madison for 287 BOPD, with no water. South Coteau Field currently has seven wells producing a daily total of over 400 BOPD.

1985

A total of 508 wells were drilled in North Dakota in 1985 (fig. 11). Successful completions were 265 for a 52 percent success rate. This compares to an overall 54 percent success rate during 1984. Of the total 134 wildcats completed, 20 of the wells were producers, a 15 percent success rate, compared to a 16 percent success rate in 1984 and 26 percent in 1983 (figs. 12 and 13). A total of 4,596,597 feet were drilled in 1985, down 1.3 million feet from 1984.

Development drilling in the Indian Hills-Elk Field area in northern McKenzie County continued at a strong pace in 1985 with over 60 wells completed as producers. In Elk Field, Superior Oil Company's Helgeson-Hoehn #13-22 was completed in the Duperow for 508 BOPD, a deeper pool discovery. Deeper pool drilling continued with success along the Nesson Anticline. Among these successes was Texaco's Texaco-Phillips et al. Riggs #10-31 well, which was completed in the Stonewall for 731 BOPD, possibly a significant new pool discovery in Blue Buttes Field.

In Williams County East Fork Field, Superior Oil Corporation re-entered a well previously abandoned by Al-Aquitaine in 1981. The Stoney Creek Al-Aquitaine 31-156-99 Hiepler #1-31 was completed in the Madison for 515 BOPD and no water, extending

production in the field more than a mile. Drilling in the Hardscrabble Field area resulted in three new pool discoveries. Of these--the Devonian Birdbear and Duperow, and the Silurian Interlake--the Birdbear and Duperow continue to produce. Immediately north of Hardscrabble Field, Harper Oil Company's Hansen #4-2 initially produced 202 BOPD through Madison perforations. The discovery well for Rosebud Field has been successfully offset four times.

Four additional Duperow pools were discovered in Divide County in 1985. Fulton Producing Company's Berco-Hanisch #1-25, the discovery well for Moraine Field, was completed in the Duperow for 180 BOPD. Moraine Field had previously been a two-well Winnipegosis field. The other Duperow discoveries were Kimberly Field, discovered by Texaco's Clara Kosteck NCT-1 #1, West Ambrose Field, discovered by Louisiana Land and Exploration's Pederson 11-18 #1, and Fillmore Field, discovered by Chieftain International's Peterson #1. Kimberly Field was previously a two-well Madison field; West Ambrose Field currently has two wells and the Chieftain well, which currently is not producing, has yet to be offset.

Development drilling in Billings/Golden Valley Counties' Knutson Field was in full swing during 1985 with 12 additional wells being successfully completed. By year's end the field consisted of 17 wells producing a daily total of nearly 4,000 barrels of oil. Wildcat activity in Billings County resulted in two new field discoveries. The Park Madison Field, a one-well field, was discovered by the Adobe Oil and Gas Luptak #23-31. Marquis Field, productive in the Devonian Duperow and Mississippian Madison, was discovered by the Canterra Petroleum US 12-30. Marquis Field now has four wells, with additional offsets expected.

In Dunn County, a Madison Field,

Barta, was discovered by the Sun Exploration Hibl #1 well (fig. 9). The Hibl had an initial potential of 312 BOPD, but an offset was completed as a dry hole.

Although development drilling highlighted activity in the northeast portion of the North Dakota Williston Basin, nine new pools were discovered. Smith Field, discovered by Petro Lewis's Peterson #1-28 well, may be significant. The well was completed for 682 BOPD from Madison perforations, with an additional pay indicated behind pipe. Completed late in 1985, an additional three wells have been drilled and production is currently averaging over 200 BOPD per well.

ADDITIONAL COMMENTS

As a point of general interest, we have included graphs (figs. 15a, 15b) indicating the geologic distribution of oil production in North Dakota. Figure 15a shows the percentage of all productive and formerly productive wells (of a total of approximately 4,500 wells) that have produced from each of the producing horizons in North Dakota. Many of these wells are now abandoned. Figure 15b breaks down the total cumulative oil production from each horizon. Thus, from the graphs you can see that 74 percent of the wells that produced did so from the Madison Group (fig. 15a) and these wells have accounted for 66 percent of the state's total oil production (fig. 15b). This amounts to about 560 million barrels of oil; a total of about 850 million barrels of oil have been produced in North Dakota since oil was discovered in 1951.

As previously mentioned, in 1982 the price of oil began to drop in response to a considerable oversupply of crude. Consequently, worldwide

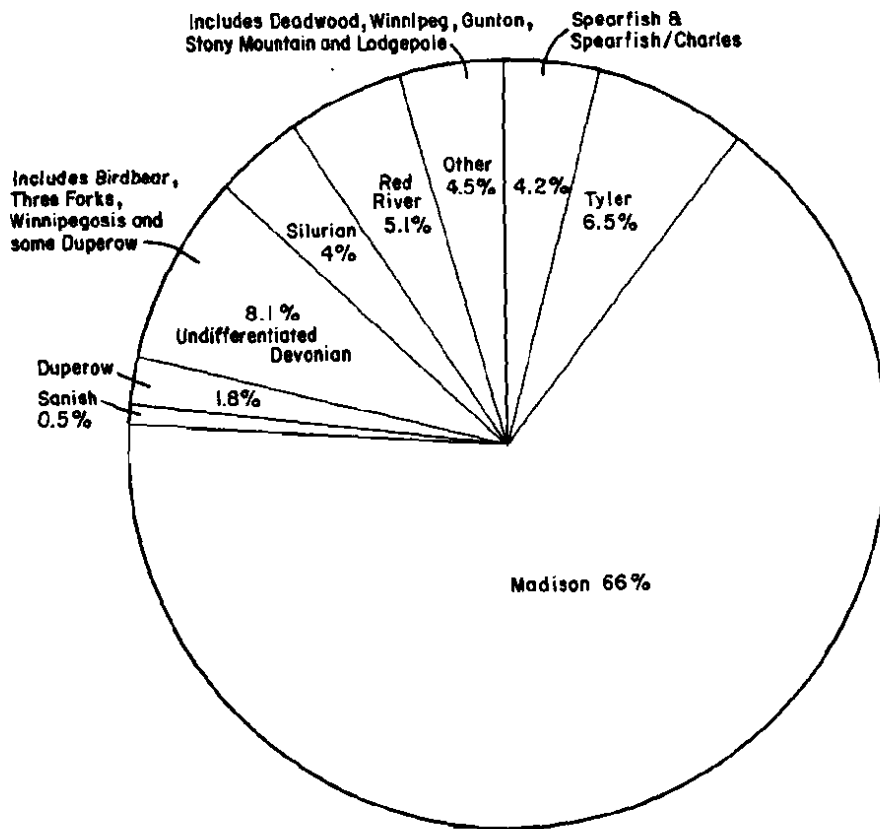
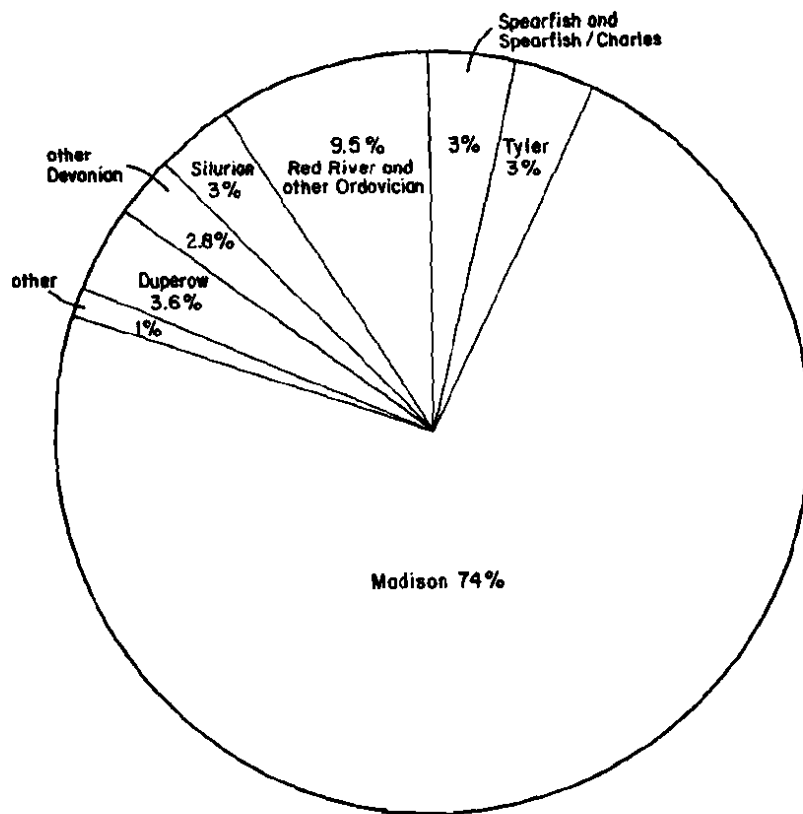


Figure 15. Geologic distribution of oil production in North Dakota. Upper graph lists the percentage of productive oil wells drilled in each horizon. Lower graph indicates percentage of total production from each horizon.

exploratory activity, including that in North Dakota, declined. In 1985 until the present, the price of oil not only continued to decline, but it became quite unstable, with rapid price fluctuations. All levels of activity in North Dakota were profoundly affected. As the number of drilling rigs continued to decline (fig. 8), confidence in the future of the industry in North Dakota also seemed to slip. Income to the state from the sale of oil and gas leasing of public lands dropped from a maximum of 69 million dollars in 1980 to 5.6 million dollars in 1985 and only 1.3 million dollars during the first three sales in 1986 (four sales are held each year) (fig. 17). Production dropped from a yearly maximum of 52.6 million barrels of oil in 1984 to 50.9 million barrels in 1985 and a projected production of about 46 million barrels in 1986 (fig. 14).

Finally, the amount of tax revenues raised as a result of oil production in North Dakota has been important in recent years (figs. 16, 17, and 18). Tax revenues collected from oil and gas production during the 1983-85 biennium decreased from

those during the previous biennium (table 2). During the 1983-85 biennium, the amount of oil and gas tax collected was \$327.4 million, a decrease of \$8.2 million from the 1981-83 biennium. The amount of tax revenues from oil and gas production represented 28 percent of the total tax collected by the State during the 1984 fiscal year; this dropped to 24 percent of the total tax collected during the 1985 fiscal year (table 2). (Tax figures were supplied by the Office of the State Tax Commissioner.)

Tables 3 and 4, included at the end of this publication, include complete listings of all of the discovery wells drilled in North Dakota during 1984 (table 3) and in 1985 (table 4). These tables also include information on discovery date, permit and order number, the number of wells currently producing in the new fields, spacing, interval perforated and initial production in each discovery well, gravity, gas-oil ratio, and water production. We have also included a map of western North Dakota showing the approximate current extent of all the known oil pools (fig. 19).

MILLIONS
OF DOLLARS

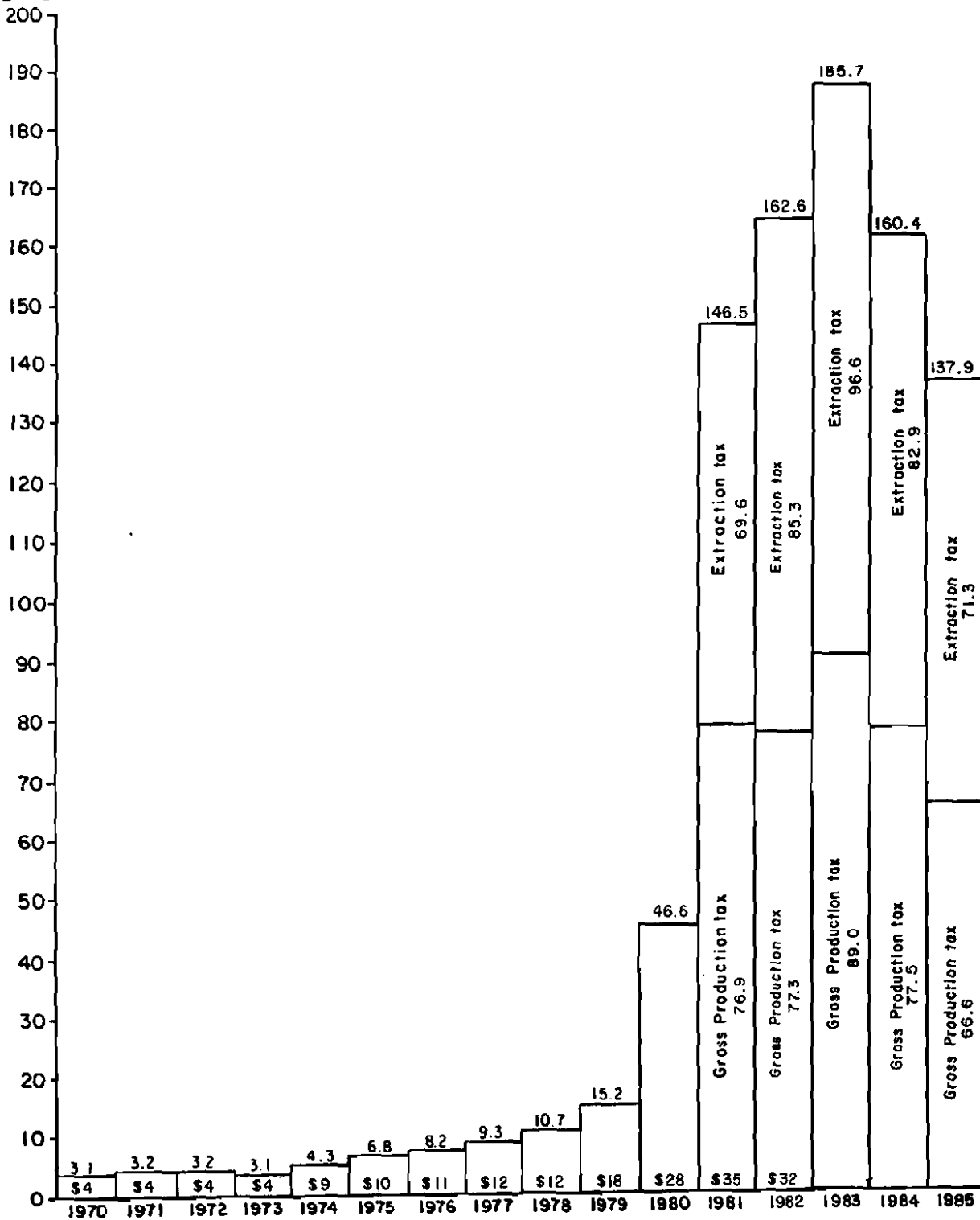


Figure 16. Graph showing the dramatic increase in oil and gas tax revenue to the State of North Dakota resulting from increased production, increased prices, and implementation of the extraction tax. Figures are in millions of dollars; thus, oil and gas tax revenue in calendar year 1983 totaled \$185,700,000. Refer also to table 2.

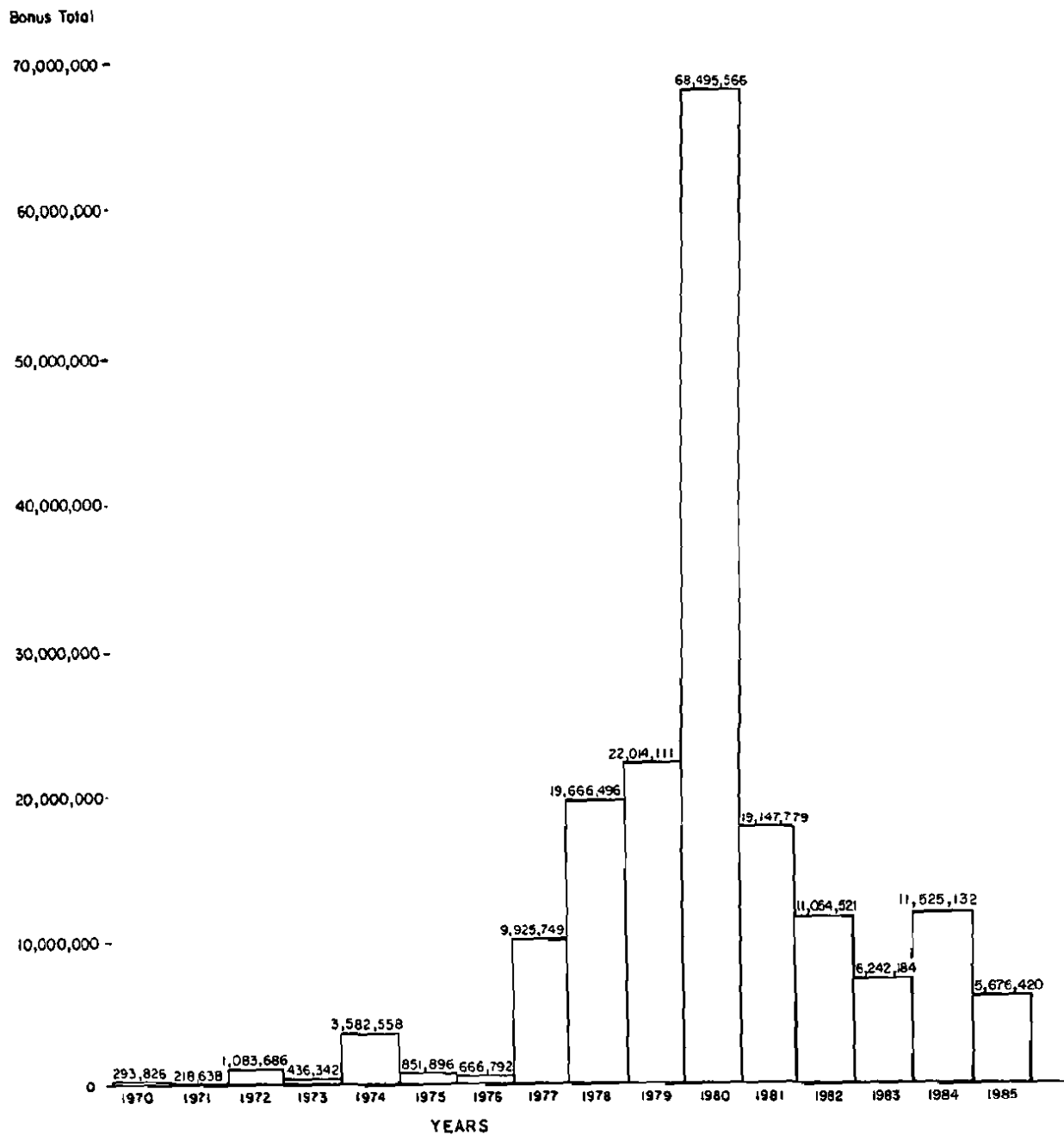


Figure 17. Income to the State of North Dakota from the sale (public auction) of oil and gas leases for state-owned lands. The leases are commonly for a 5-year term, with a 1/6 royalty rate and an annual rental of \$1.00 per mineral acre. Bidding is on the bonus, which is for a minimum of \$1.00 per mineral acre.



Figure 18. Average price per acre paid in oil and gas lease sales (see fig. 16 also). Lower per-acre prices reflect large offerings in eastern North Dakota away from known producing areas. Highest prices are for lands with good potential.

TABLE 2.--Percentage of Tax Income to State of North Dakota from Various Sources (figures given as percent of total revenues).

<u>Tax</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>
Oil and Gas *	9	22	35	35	28	24
Sales	33	29	26	27	29	26
Income	26	25	17	16	20	27
Motor Vehicle	14	10	10	7	11	11
Coal Severance	4	4	4	4	5	6
Cigarette	3	2	2	2	2	2
Other	12	8	6	9	5	4

* Oil and gas taxes equal the sum of the revenues from the gross production tax and the oil extraction tax.

The importance of oil and gas tax revenues to the State of North Dakota is shown on this table. Oil and gas taxes increased from 9 percent of total tax revenues in fiscal year 1980 to 35 percent in 1982 and 1983. During that same period of time, total tax revenues were as follows (oil and gas taxes in parentheses): \$325.8 million (\$29.7 million) in 1980; \$402.9 million (\$87.6 million) in 1981; \$484.3 million (\$169.2 million) in 1982; \$471.8 million (\$166.7 million) in 1983; \$621.9 million (\$176.8 million) in 1984; and \$630.7 million (\$150.9 million) in 1985.

TABLE 3.—Oil and Gas Discoveries in North Dakota During 1984.

COUNTY FILE NO. ORDER NO.	COMP. DATE	OPERATOR, WELL NAME, LOCATION	FIELD -POOL (NUMBER OF WELLS CURRENTLY IN POOL)	SPACING	TOTAL DEPTH	INTERVAL PERFORATED	INIT. PROD. (CURRENT DAILY PROD. -BBLs. OIL)	GRAV.	GOR	WATER
BILLINGS 10385 3545	20FEB84	SAMSON RESOURCES COMPANY CAMERON #1-20 NESW SEC. 20-139-102	DANCE CREEK -PNT (1)	160	9000	7702- 7707	53 (17)	36.0	.00	.00 X
BILLINGS 10877 3772	09SEP84	PROPEL ENERGY CO. EDNA B. EGLY 1 SWNE SEC. 21-142-100	TREE TOP -NPK (1)	160	11450	10769-10795	187 (31)	43.5	2379.00	.00 X
BOTTINEAU 11278 3869	05DEC84	LEWIS OIL CORP. SEW 22-8 SENE SEC. 22-162- 79	REFUGE -NPKM (1)	80	3330	3229- 3247	192 (10)	35.4	.00	.00 X
BOTTINEAU 10649 3690	17MAY84	KENNEDY & MITCHELL, INC. MAGNUSON TURTLE MOUNTAIN #55-752-1 SESW SEC. 11-163- 77	RED ROCK -TRS (1)	40	3300	3002- 3031	18 (5)	35.0	.00	48.00 B
BOTTINEAU 10831 3661	14JUN84	M & J OIL COMPANY HELEN SIDENER 43-1 NESE SEC. 1-160- 83	MOUNTROSE -NPKB (6)	40	4496	4332- 4334	15 (0)	29.0	100.00	28.00 B
BURKE 11168 3898	29OCT84	ALBRITTON RESOURCES, INC. DALIN 25-1 SWSW SEC. 25-163- 93	STAMPEDE -NPKS (1)	80	6580	6254- 6284	33 (0)	33.0	1500.00	298.00 B
BURKE 10556 3541	20JAN84	MONSANTO OIL COMPANY KINSON-CARLSON #1 NWSW SEC. 12-159- 90	NIOBE -NPKB (3)	80	7200	6921- 6942	180 (18)	27.4	1078.00	7.00 B
BURKE 11039 3795	11SEP84	CENTURY OIL & GAS CORPORATION OLSON 29-7 SWNE SEC. 29-161- 90	SOUTH COTEAU -NPKB (7)	80	6875	6540- 6557	287 (46)	32.5	1167.00	.00 X
BURKE 10567 3601	20FEB84	MONSANTO OIL COMPANY KINSON-ECKERT #1 SESE SEC. 1-159- 91	THOMPSON LAKE -NPKB (1)	80	7526	7256- 7277	69 (8)	30.7	290.00	76.00 B
BURKE 10683 3521	21APR84	CHANDLER & ASSOCIATES, INC. HAYTON #2-33 NNE SEC. 33-162- 90	DALE -NPKB (6)	80	6270	6086- 6098	14 (14)	38.0	930.00	13.00 B
DIVIDE 10401 3510	01JAN84	SOLAR PETROLEUM, INC. JOHNSON #1 SESW SEC. 8-161- 99	MUSTA -DD (2)	320	11771	9208- 9216	38 (59)	41.5	502.00	5.00 X

TABLE 3.—Oil and Gas Discoveries in North Dakota During 1984.—Continued

COUNTY FILE NO. ORDER NO.	CONF. DATE	OPERATOR, WELL NAME, LOCATION	FIELD	TOTAL	INTERVAL	INIT. PROD.				
			-POOL (NUMBER OF WELLS CURRENTLY IN POOL)			SPACING	DEPTH	PERFORATED	(CURRENT DAILY PROD. -BBLs. OIL)	GRAV.
DIVIDE 10402 3652	28JAN84	DONALD C. SLAWSON GLASDE #1-36 NWSW SEC. 36-161- 96	UPLAND -ORR (1)	160	12295	12010-12034	55 (0)	56.0	3182.00	17.00 X
DIVIDE 10402 3551	26FEB84	DONALD C. SLAWSON GLASDE #1-36 NWSW SEC. 36-161- 96	UPLAND -DG (1)	320	12295	11844-11882	50 (0)	53.0	9200.00	52.00 X
DIVIDE 10607 3575	12MAR84	TXP OPERATING COMPANY TXPOC-MORRIS #1-25 SESE SEC. 25-162-102	CLINTON -ORR (1)	320	11230	11012-11051	1288 (160)	51.0	264.00	.00 X
DIVIDE 10927 3850	03OCT84	THE LOUISIANA LAND AND EXPLORATION COMPANY STATE 1 43-6 SESE SEC. 6-163-100	COLGAN -DD (1)	160	10908	8304- 8308	76 (19)	33.0	566.00	8.00 B
DUNN 10735 3836	18SEP84	AMOCO PRODUCTION COMPANY WILLIAM C. LUBKE #1A SNW SEC. 11-146- 96	RATTLESNAKE POINT -ORR (1)	320	14369	14052-14155	92 (40)	49.9	3326.00	29.00 B
MC HENRY 10825 4518	07NOV84	TRI-W CORP. WATNE 1 SESW SEC. 29-159- 80	WAKE -HNGB (9)	40	4204	4192- 4204	55 (11)	26.0	338.00	15.00 X
MC KENZIE 10425 3651	02MAY84	PENNZOIL COMPANY SNOWCOVER #1J-22BN SESW SEC. 13-147-102	SNOWCOVER -DD (1)	160	13388	11353-11378	342 (57)	39.2	1350.00	.00 X
MC KENZIE 11072 3866	27DEC84	PUMA PETROLEUM CO. PASCHKE 3-18 E2NW SEC. 18-149-103	WINTER BUTTE -MNDN (1)	160	9700	9556- 9566	23 (9)	35.0	.00	169.00 B
MC KENZIE 10658 3713	16JUN84	THE SUPERIOR OIL COMPANY NELSON #2-2 SWSE SEC. 1-152-102	INDIAN HILL -DD (5)	320/ 160	13800	11453-11486	203 (116)	48.0	473.00	29.00 X
MC KENZIE 11125 3859	08NOV84	AMINDIL USA, INC. STATE ROGNESS 1-43-16 SWSE SEC. 16-148-100	BULLY -ORR (2)	320	14089	13944-13954	0 (0)	58.0	13587.00	.00 X
MC KENZIE 10816 3822	07OCT84	HNG OIL CO. NEEK 11 1 SESW SEC. 11-149-101	ANTELOPE CREEK -ORR (2)	320	13950	13801-13818	336 (18)	49.7	1488.00	.01 X
MC KENZIE 10988 3816	26OCT84	TEXACO INC. TEXACO ET AL STATE OF N.D. "D" 1 NWSE SEC. 10-150- 96	JOHNSON CORNER -OSM (1)	320	14170	13704-13713	362 (0)	45.7	2555.00	186.00 B

TABLE 3.--Oil and Gas Discoveries in North Dakota During 1984.--Continued

COUNTY FILE NO. ORDER NO.	COMP. DATE	OPERATOR, WELL NAME, LOCATION	FIELD -POOL (NUMBER OF WELLS CURRENTLY IN POOL)	SPACING	TOTAL DEPTH	INTERVAL PERFORATED	INIT. PROD. (CURRENT DAILY PROD. -BBLs. OIL)	GRAV.	GOR	WATER
WILLIAMS 10886 3719	25JUN84	SAGE ENERGY COMPANY L. GREEN 41-17 NENE SEC. 17-152-103	SUGAR BEET -HMFAR (1)	160	9150	8940- 8950	30 (7)	38.6	.00	150.00 B
WILLIAMS 10893 3771	27AUG84	ATLANTIC RICHFIELD CO. ARCO EIDSVUOG 1 C NE SEC. 1-157-100	DUBLIN -HMCN (2)	160	13348	8831- 8840	115 (80)	30.6	278.00	4.00 B

TABLE 4.—Oil and Gas Discoveries in North Dakota During 1985.

COUNTY FILE NO. ORDER NO.	COMP. DATE	OPERATOR, WELL NAME, LOCATION	FIELD -POOL (NUMBER OF WELLS CURRENTLY IN POOL)	SPACING	TOTAL DEPTH	INTERVAL PERFORATED	INIT. PROD. (CURRENT DAILY PROD. -BBLs. OIL)	GRAV.	GOR	WATER
BILLINGS 11344 3957	02MAR85	CANTERRA PETROLEUM, INC. BN #6-31 SENW SEC. 31-140-101	MARQUIS -DD (1)	160	12175	10616-10634	211 (44)	40.9	844.00	7.00 B
BILLINGS 11501 4071	09JUL85	CANTERRA PETROLEUM, INC. US 12-30 NWSW SEC. 30-140-101	MARQUIS -MMFB (2)	160	10980	9306- 9320	85 (27)	40.0	600.00	77.00 B
BOTTINEAU 11779 4120	12NOV85	TURTLE MOUNTAIN GAS & OIL, INC. BRANDT GOODMAN 1-9 SENW SEC. 9-160- 78	SOUTH STARBUCK -TRS (1)	40	3280	3244- 3252	27 (15)	35.0	.00	.00 X
BOTTINEAU 11804 4207	29OCT85	GEORESOURCES, INC. ANDERSON ET AL 1-24 NWSW SEC. 24-163- 79	LEONARD -MMCN (1)	40	3310	3136- 3144	66 (68)	37.0	.00	5.00 B
BOTTINEAU 264 4516	24DEC85	MURRY, STENJHEM, MURRY LOTTIE GREEN #1 SESE SEC. 23-163- 80	NORTH SERGIS -MMRM (1)	40	3528	3338- 3344	8 (0)	.0	.00	12.00 B
BOTTINEAU 11398 4088	21JUN85	GENERAL ATLANTIC ENERGY CORP. BLUE STREAK 21-26 NENW SEC. 26-163- 81	HULSE COULEE -MMRM (1)	40	3525	3469- 3495	5 (0)	.0	.00	10.00 B
BOTTINEAU 11400 4069	02MAY85	GENERAL ATLANTIC ENERGY CORP. MAD MAX 1 SENE SEC. 21-161- 81	MAD MAX -MM (1)	40	4150	4054- 4062	16 (0)	28.0	.00	10.00 B
BOTTINEAU 11448 4022	12APR85	VALERO PRODUCING CO. TREND-SKAADEN 43-28 NESE SEC. 28-163- 77	HARAM -MMT (2)	40	4100	3017- 3021	72 (68)	32.3	.00	278.00 B
BOWMAN 11454 4123	28JUN85	QUADRA OIL & GAS, INC. PALCZEWSKI 34-11 NENW SEC. 34-129-100	SOUTH GOLD -ORR (1)	320	9380	9147- 9152	105 (18)	39.5	.01	397.00 B
BURKE 11161 3945	04JAN85	TYREX OIL CO. LEICHTNAM 43-30 NESE SEC. 30-161- 89	SHOCKLEY -MMBB (2)	80	6420	6275- 6290	68 (16)	30.0	.00	78.00 B
BURKE 11616 4156	14AUG85	GENERAL ATLANTIC ENERGY CORP. GAEC PICKETT 34-23 SWSE SEC. 23-162- 90	PICKETT -MMSB (3)	80	6200	5987- 5997	68 (25)	31.5	.00	21.00 B

TABLE 4.--Oil and Gas Discoveries in North Dakota During 1985.--Continued

COUNTY FILE NO. ORDER NO.	COMP. DATE	OPERATOR, WELL NAME, LOCATION	FIELD -POOL (NUMBER OF WELLS CURRENTLY IN POOL)	SPACING	TOTAL DEPTH	INTERVAL PERFORATED	INIT. PROD. (CURRENT DAILY PROD. -BBLs. OIL)	GRAV.	GOR	WATER
MURKE 11691 4167	10OCT85	CENTURY OIL & GAS CORP. ANDERSON 24-5 SUNW SEC. 24-161- 91	CLAYTON -MM (1)	80	6900	0- 0	0 (0)	.0	.00	.00 X
DIVIDE 10126 4153	13JUL85	HNG OIL CO. ANDERSON-STATE 30 #1 NESW SEC. 30-161-102	DANEVILLE -DW (1)	160	11366	10048-10057	143 (0)	39.0	.00	175.00 B
DIVIDE 10607 4178	10SEP85	TXP OPERATING COMPANY TXPOC-NORRIS #1-25 SESE SEC. 25-162-102	CLINTON -OG (1)	160	11230	10832-10854	208 (160)	38.6	817.00	.00 X
DIVIDE 10904 3943	23JAN85	FULTON PRODUCING CO. BERGD-HANISCH 1-25 SESW SEC. 25-161- 98	MORaine -DD (1)	160	10584	9336- 9346	180 (62)	38.0	278.00	5.00 B
DIVIDE 11235 3969	15MAR85	TEXACO INC. CLARA KOSTECK NCT-1 #1 SESW SEC. 7-163- 95	KIMBERLY -DD (1)	160	10775	8151- 8162	314 (0)	39.8	223.00	45.00 B
DIVIDE 11284 3941	05FEB85	LOUISIANA LAND & EXPLORATION CO. PEDERSON 11-10 #1 NNW SEC. 18-163- 99	WEST AMBROSE -DD (1)	160	10983	8364- 8373	77 (27)	37.0	610.00	170.00 B
DIVIDE 11589 4206	07SEP85	LOUISIANA LAND & EXPLORATION CO. HEUER 41-20 NENE SEC. 20-161- 95	SADLER -MMR (1)	160	10632	7428- 7514	52 (46)	35.4	1155.00	221.00 B
DIVIDE 11504 4230	01NOV85	CHIEFTAIN INTERNATIONAL, INC. ARCHIE S. PETERSON 1 SUNW SEC. 31-163- 97	FILLMORE -DD (1)	160	9901	8467- 8476	50 (30)	.0	832.00	188.00 B
DUNN 11543 4182	16AUG85	SUN EXPLORATION & PRODUCTION CO. HIBL 1 NNW SEC. 7-141- 97	BARTA -MMFB (1)	160	13160	9562- 9565	312 (68)	40.5	1000.00	44.00 B
MC KENZIE 6532 4233	14NOV85	PENNZOIL COMPANY DEPCD #1-15NW SWE SEC. 15-147-101	BULL MOOSE -DD (1)	320	13225	11187-11194	280 (0)	42.7	696.00	.00 X
MC KENZIE 7823 4168	03JUL85	AMOCO PROD CO. FEDERAL "C" #1 NENE SEC. 4-146-100	TRAILSIDE -MMCN (1)	160	11430	9362- 9370	115 (106)	.0	878.00	30.00 B

TABLE 4.—Oil and Gas Discoveries in North Dakota During 1985.—Continued

COUNTY FILE NO. ORDER NO.	COMP. DATE	OPERATOR, WELL NAME, LOCATION	FIELD -POOL (NUMBER OF WELLS CURRENTLY IN POOL)	SPACING	TOTAL DEPTH	INTERVAL PERFORATED	INIT. PROD. (CURRENT DAILY PROD. -BBLs. OIL)	GRAV.	GOR	WATER
MC KENZIE 8439 4035	21MAR85	TRAVERSE OIL COMPANY NYGAARD #1-19 SESW SEC. 19-151-100	PATENT GATE -MHCN (1)	160	13956	9562- 9593	33 (20)	40.0	1515.00	72.00 B
MC KENZIE 9057 4065	05MAY85	TEXACO, INC. TEXACO-PHILLIPS ET AL RIGGS #10-31 NWSW SEC. 31-151- 95	BLUE BUTTES -SOS (24)	320	14094	13540-13549	731 (207)	52.2	2549.00	8.00 B
MC KENZIE 11093 4180	18AUG85	GETTY OIL CO. COVERED BRIDGE "A" 10-6 SESW SEC. 10-146-102	COVERED BRIDGE -HEK (1)	160	11266	10632-10655	36 (25)	41.1	1250.00	4.00 B
MC KENZIE 11110 3934/4163	17JAN85	AMERADA HESS CORP. SWENSON 20-22 SESW SEC. 20-152- 95	HAWKEYE -DRR (1)	320	14900	13869-13934	148 (0)	57.2	6615.00	30.00 B
MC KENZIE 11198 3922	30JAN85	TEXACO INC. OSCAR JONSRUD 1 NENW SEC. 5-151- 96	EDGE -SI (1)	320	14025	12291-12322	1082 (0)	49.2	2218.00	243.00 B
MC KENZIE 11198 4252	20NOV85	TEXACO INC. OSCAR JONSRUD 1 NENW SEC. 5-151- 96	EDGE -DD (1)	320	14025	11160-11176	70 (50)	40.5	3214.00	55.00 B
MC KENZIE 11204 3923	05JAN85	TEXACO INC. TEXACO EXCHANGE OIL & GAS 1 SESW SEC. 17-151- 96	DIMMICK LAKE -SI (2)	320	14100	12382-12431	912 (37)	46.1	1644.00	48.00 B
MC KENZIE 11214 3944	05FEB85	DEPCO, INC. NORTH BRANCH 22-35 SESW SEC. 35-148-102	NORTH BRANCH -DD (2)	320	13435	11387-11394	212 (312)	41.0	840.00	.00 X
MC KENZIE 11313 4155	16MAY85	MILESTONE PETROLEUM, INC. FEDERAL HEART 12-6 NWSW SEC. 6-146- 99	WEST BUTTE -DRR (1)	320	13852	13578-13587	31 (0)	54.6	32490.00	110.00 B
MC KENZIE 11313 4155	22JUL85	MILESTONE PETROLEUM, INC. FEDERAL HEART 12-6 NWSW SEC. 6-146- 99	WEST BUTTE -MHCN (1)	160	13852	9654- 9664	239 (59)	43.1	836.00	232.00 B
MC KENZIE 11549 4181	21SEP85	BASIC EARTH SCIENCE SYSTEMS, INC. ROSEBUD 22-11 SESW SEC. 11-153-101	BAKER -DRR (1)	320	13525	13253-13269	325 (106)	46.0	2258.00	.00 X

TABLE 4.--Oil and Gas Discoveries in North Dakota During 1985.--Continued

COUNTY FILE NO. ORDER NO.	COMP. DATE	OPERATOR, WELL NAME, LOCATION	FIELD -POOL (NUMBER OF WELLS CURRENTLY IN POOL)	SPACING	TOTAL DEPTH	INTERVAL PERFORATED	INIT. PROD. (CURRENT DAILY PROD. -BBLs. OIL)	GRAV.	GOR	WATER
MC KENZIE 11401 4126	18JUN85	TEXACO INC. HARLEY OLSON #1 NESW SEC. 5-151-96	EDGE -HMCN (1)	80	12450	9136- 9172	19 (21)	44.0	1157.00	70.00 B
MC KENZIE 11536 4306	13DEC85	MILESTONE PETROLEUM, INC. MPI 43-7 NESE SEC. 7-146-102	PIERRE CREEK -DB (1)	160	13282	10992-11027	281 (335)	44.6	1181.00	437.00 B
MC KENZIE 11503 4227	21SEP85	SUPERIOR OIL CO. HELGESON-MOEHN 13-22 SESW SEC. 13-152-102	ELK -DD (1)	160	11620	11440-11456	508 (313)	45.0	476.01	.00 X
STARK 11298 3940	22JAN85	HRUBERTZ OIL CO. DECKER 1-31 NENW SEC. 31-140-95	DAVIS BUTTES -PNT (3)	160	7925	7808- 7814	122 (32)	31.3	.00	9.00 B
WILLIAMS 8441 4017	03MAR85	HAPCO PRODUCTION COMPANY TOFTE #1-1 NENE SEC. 1-153-100	CRAZY MAN CREEK -HMCN (3)	160	14377	9760- 9788	134 (27)	38.1	784.00	7.00 B
WILLIAMS 8861 4228	10SEP85	AL-AQUITAINE EXPL. LTD. STONEY CREEK AL-AQUITAINE 31-156-99 HIEPLER 1-31 SESW SEC. 31-156-99	EAST FORK -HMCN (7)	160	14182	9420- 9440	515 (239)	37.0	.00	.00 X
WILLIAMS 10676 4054	17MAY85	FULTON PRODUCING COMPANY UNION-MCGINNITY #1-6 SESW SEC. 6-158-95	TEMPLE -DD (2)	160	12250	10053-10287	110 (42)	38.8	455.00	157.00 B
WILLIAMS 11137 4133	01JUL85	GULF OIL CORP. PEDERSON 5-24-4C NWSW SEC. 24-153-102	HARDSCRABBLE -DD (3)	160	11200	11032-11050	191 (329)	38.0	746.00	.00 X
WILLIAMS 11517 4232	19NOV85	BMAB, INC. C. MORTENSON 3-44 SESE SEC. 33-155-96	WEST CAVA -ORR (1)	320	12950	12707-12804	11 (0)	50.6	99999.00	159.00 B
WILLIAMS 11346 4056	25MAR85	SUPERIOR OIL COMPANY PETERSON FLB #24-33 NWSE SEC. 24-155-101	TANDY -ORR (1)	160	13720	13493-13552	60 (62)	47.2	633.00	61.00 B
WILLIAMS 11420 4031	16APR85	HARPER OIL CO. HANGEN 4-2 NWNW SEC. 2-153-102	ROSEBUD -HMCN (3)	160	9530	9348- 9368	202 (121)	36.5	713.00	36.00 B
WILLIAMS 11459 4301	05AUG85	SUN EXPLORATION & PRODUCTION CO. TOFTE FEDERAL 1 S2NE SEC. 23-153-102	HARDSCRABBLE -DB (1)	160	11191	10650-10664	13 (0)	39.8	1859.00	35.00 B

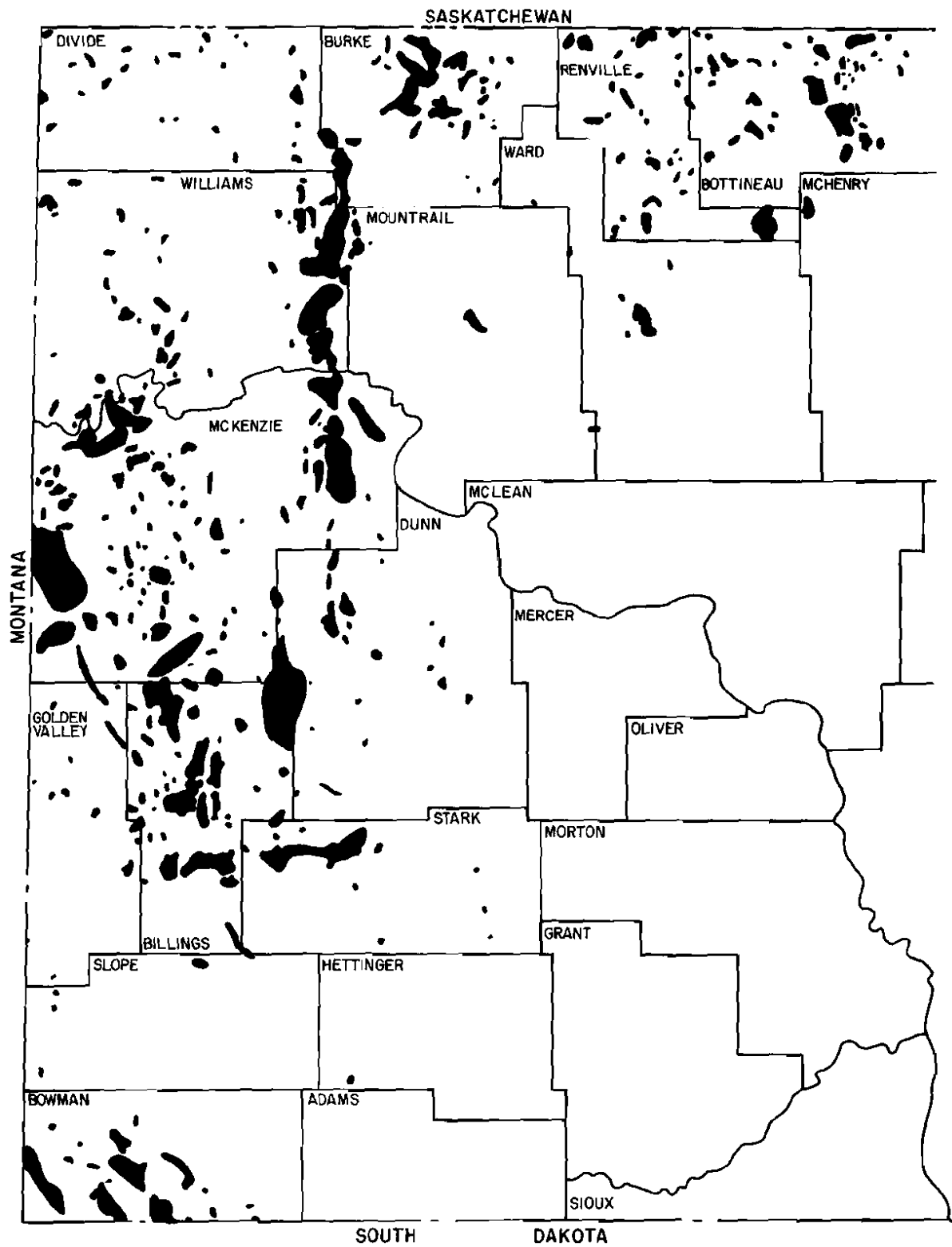


Figure 19. Map of western North Dakota showing approximate extent of all known oil pools as of August 1, 1986.

REFERENCES

- Anderson, S. B., and Eastwood, W. P., 1968, Natural gas in North Dakota: American Association of Petroleum Geologists Memoir 9, v. 2, p. 1304-1326.
- Anderson, S. B., and Bluemle, J. P., 1982, Oil exploration and development in the North Dakota Williston Basin: 1981 update: North Dakota Geological Survey Miscellaneous Series 62, 29 p.
- Anderson, S. B., and Bluemle, J. P., 1984, Oil exploration and development in the North Dakota Williston Basin: 1982-1983 update: North Dakota Geological Survey Miscellaneous Series 65, 33 p.
- Bluemle, J. P., Anderson, S. B., and Carlson, C. G., 1980, North Dakota stratigraphic column: North Dakota Geological Survey publication.
- Dow, W. G., 1974, Application of oil correlation and source-rock data to exploration in Williston Basin: American Association of Petroleum Geologists Bulletin, v. 58, p. 1253-1262.
- Folsom, C. B., Jr., 1980, A history of the North Dakota Geological Survey: North Dakota Geological Survey Miscellaneous Series 58, 51 p.
- Gerhard, L. C., and Anderson, S. B., 1981, Oil exploration and development in the North Dakota Williston Basin: 1980 update: North Dakota Geological Survey Miscellaneous Series 59, 19 p.
- Gerhard, L. C., Anderson, S. B., LeFever, J. A., and Carlson, C. G., 1982, Geological development, origin, and energy and mineral resources of the Williston Basin, North Dakota: American Association of Petroleum Geologists Bulletin, v. 66, p. 989-1020.